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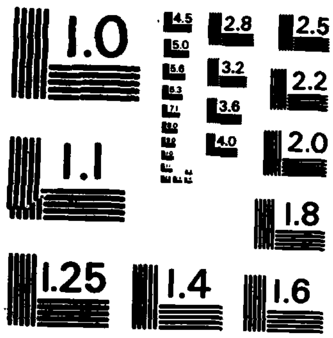

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U.S. MARINE CORPS CONTAINERIZED AMMUNITION SYSTEMS STUDY (1985-1995)

LTCOL R.J. YEOMAN
DEPUTY CHIEF OF STAFF FOR PLANS
DEVELOPMENT CENTER
MARINE CORPS DEVELOPMENT AND EDUCATION COMMAND
QUANTICO, VIRGINIA 22134

JULY 1985

FINAL REPORT

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The focus of this study is on the movement of containerized ammunition the beach to using units, including handling and retrograding empty containers. These functions are examined for the buildup ashore of the follow-on echelon and for subsequent resupply operations. Classes of supply other than ammunition are not considered.

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From: Commandant of the Marine Corps

Subj: MARINE CORPS CONTAINERIZED AMMUNITION SYSTEM STUDY (1985-1995)

Encl: (1) Final Report, Marine Corps Containerized Ammunition System Study (1985-1995)

1. The objectives of this study were to:

a. Develop concepts of containerized ammunition support for a MAF and a MAB from initial mount-out through subsequent operations ashore during the midrange period.

b. Identify organizational deficiencies in implementing the containerized ammunition system concept as developed.

c. Recommend priorities of tasks to be accomplished to alleviate deficiencies.

d. Recommend priorities of functions during an amphibious operation.

e. Identify and prioritize ammunition containers required during the landing of the AE and AFOE when considering the assault and sustained rates and to recommend marshalling and container identification control techniques.

2. The objectives were met, and the study is approved for distribution. The scope of this study was limited to the handling of containerized ammunition in an ACA in order to keep the effort at a manageable level. As such, the study was designed to yield basic information with regard to container doctrine and requirements to facilitate further research. The concepts and requirements described by this work are thus starting points which require further refinement and analysis in order to use them as the basis for decisions regarding equipment, structure, and procedures. The methodology developed and illustrated in the study can be applied to follow-on work by Marine Corps analytical personnel and planners.

Subj: MARINE CORPS CONTAINERIZED AMMUNITION SYSTEM STUDY (1985-1995)

3. A copy of this letter will be affixed inside the front cover of the study report prior to distribution.

RAY "N" FRANKLIN
Major General U.S. Marine Corps
Deputy Chief of Staff for RD&S

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CONTENTS

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I. EXECUTIVE SUMMARY

A. PURPOSE

This study was conducted by System Planning Corporation (SPC) for Headquarters Marine Corps to identify concepts, capabilities, and shortfalls for the handling and movement of containerized ammunition in a Marine Corps Amphibious Objective Area (AOA).

B. BACKGROUND AND SCOPE

The study addresses both Class V(A) (air ammunition) and Class V(W) (ground ammunition) for Marine Corps forces in the 1985-1995 time period. Some of this ammunition will be delivered to the beach in the large (8'x8'x20') ISO containers increasingly used by the shipping industry. Some ammunition will continue to be delivered to the beach in breakbulk (palletized) form. The focus of this study is on the movement of containerized ammunition from the beach to using units, including handling and transporting full containers, unstuffing containers, and retrograding empty containers. These functions are examined for the buildup ashore of the assault follow-on echelon (AFOE) and for subsequent resupply operations. Classes of supply other than ammunition are not considered. The central issues are:

- (1) What should be the operational concept for handling containerized ammunition in the AOA?;
- (2) Within the developed concept, are planned Marine Corps equipments and organizations adequate to handle anticipated levels of containerized ammunition? If not, what changes should be made?

C. APPROACH AND METHODOLOGY

The approach builds on current Marine Corps plans for organizing, equipping, and operating its forces. The study includes collection background data on Marine Corps organization, equipment, and planning factors; information on DoD policies and doctrines of the other services for movement and control of shipping containers; and information on alternative items of equipment for the movement and handling of containerized ammunition.

A typical deployment of a Marine Amphibious Force (MAF) is developed and analyzed to provide estimates of resupply requirements for the following categories of ammunition:

Class V(W)	Class V(A)
Artillery	Bombs
Demolitions	Missiles
Mortars	Rockets
Small arms	Gun ammunition
Anti-air missiles	ECM devices
Tanks	
Antitank	
LAV (25)	

Estimates of these requirements are developed in short tons and converted to the corresponding numbers of container equivalent units (CEUs). A CEU is the nominal container-full of ammunition based on achievable packaging densities for palletized ammunition in standard 8'x8'x20' (ISO) containers.

A generalized ammunition supply network (Figure I-1) is defined consistent with current Marine Corps doctrine for handling breakbulk ammunition. This network contains the following successive nodes:

- Beach Transfer Point (BTP) - the location where materiel is delivered to the beach
- Beach Support Area (BSA) - an area at or near the beach for directing and expediting the movement of materiel inland
- Ammunition Supply Point (ASP) - a site where ammunition is stored and controlled for further distribution to using units or munition dumps
- Munition dump - an assembly, storage, and distribution site between using units and ASPs
- Using unit - an aviation or ground unit that requires ammunition resupply

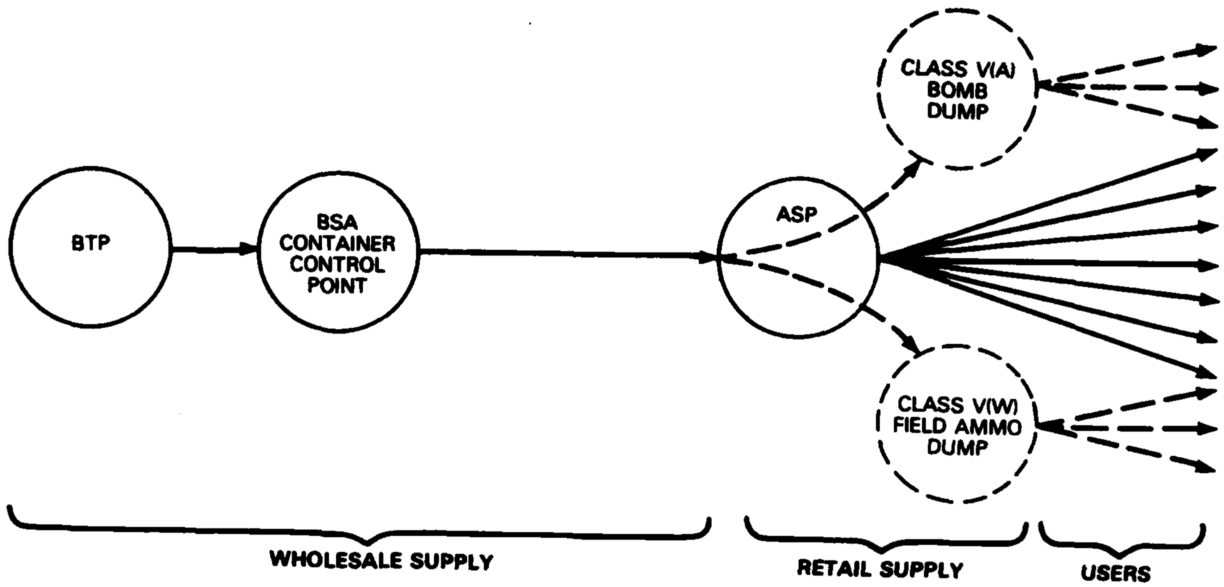

FIGURE I-1.
CONCEPTUAL AMMUNITION NETWORK

Information on key FLS equipment items is collected and productivity estimates are developed for essential MHE tasks at each node and for transportation between nodes. Information on alternatives to FLS equipment items is compiled from Army and Air Force research and development programs and from industry sources. This information is qualitatively assessed to formulate recommendations for further testing and analyses as means to enhance Marine Corps capabilities to handle containerized ammunition.

Based on the data and analyses above, the study develops and presents a concept for handling containerized ammunition using FLS equipments. The concept is developed to minimize equipment requirements while providing the capability to meet required rates for receiving ammunition at the beach and delivering it to using units. This concept describes how far forward ammunition containers should be moved, how the flow of containers should be controlled, when and where containers should be unstuffed, and what items of equipment are needed at each node. Quantitative analyses are performed to estimate the numbers of key equipment items needed for a typical MAF deployment based on equipment productivity estimates (assuming a 20-hour work day with no mechanical failures or losses to enemy action) and

required rates for receiving and delivering ammunition at each node in the resupply network.

D. ANALYTIC DISCUSSION

Containerized ammunition is expected to arrive at the beach as part of the assault follow-on echelon (AFOE) and during subsequent resupply operations. How much of the total ammunition requirement will be containerized is uncertain. A reasonable estimate for the most demanding requirement for container handling equipment, however, is that all ammunition for these phases of an amphibious operation will be delivered in containers.

Expressing requirements in CEUs per day, the resupply requirements for a typical MAF deployment are dominated by aircraft and artillery:

	Sustaining Rates	Intense Rates
Class V(W)		
Artillery	23.4	59.4
Other	9.6	19.2
	33.0	78.6
Class V(A)		
Bombs	48.9	61.2
Missiles	26.8	33.5
Other	9.1	11.4
	84.8	106.1
Total	117.8	184.7

Key equipment items in the FLS are the lightweight amphibious container handler (LACH), the MK48/MK14/MK17 logistics vehicle system, the rough terrain container handler (RTCH), and the 4000-lb. rough terrain fork lift (4K RTFL). The MK48 is the power unit for pulling either the MK14 or MK17 rear body unit. The MK14 is designed to haul standard ISO containers but it can also haul palletized loads. The LACH can offload fully loaded containers from beached landing craft and load them on MK48/MK14s for movement inland. Alternatively, loaded containers can be placed on MK48/MK14s

with shipboard cranes and brought ashore over the Navy-operated elevated causeway (ELCAS). The RTCH can load and unload fully loaded containers from the MK48/MK14 and can be used to move containers to and from storage areas at an ASP or munition dump. The 4K RTFL can be used to unstuff containers, to move palletized ammunition to and from storage, and load/offload trucks with palletized ammunition. A MAF has 12 LACHs, 6 RTCHs, 116 4K RTFLs, and 145 MK48/MK14s. These items are also aboard Maritime Preposition Ships (MPS); a MAF deployed with MPS, for example, would have an additional 4 LACHs, 10 RTCHs, 24 4K RTFLs, and 48 MK48/MK14s.

An important consideration in the development of a concept for handling containerized ammunition is where the containers should be unstuffed. Theoretically, they could be unstuffed at the beach and all ammunition could be carried forward in breakbulk form. At the other extreme, all ammunition could be delivered to using units in containers; however, this may not be practical for some units. Intermediate solutions would unstuff containers at ASPs and ammunition dumps.

Because space is usually at a premium at the BTP, standard practice is to clear the beach of incoming materiel as rapidly as possible. Because considerable space is required to unstuff large numbers of ammunition containers, these operations should be conducted at ASPs or ammunition dumps inland. Carrying containers inland to the ASP also makes more efficient use of MHE and transporters because containerized ammunition can be loaded and offloaded much more rapidly than the same amount of palletized ammunition.

If containerized ammunition is available at an ASP and the contents of these containers are to be shipped to a dump for issue in breakbulk form, then whether or not it pays to ship the ammunition from the ASP to the dump in containers depends on the throughput of ammunition required. Shipping containerized ammunition rather than breakbulk ammunition creates requirements for the RTCH and eliminates requirements for the 4K RTFL to load/offload transporters. Based on life cycle costs a reduction of two 4K RTFLs for one additional RTCH is a favorable trade. The analysis in Chapter VII indicates that these kinds of savings can be achieved only if

the required delivery rate to the dump is more than about 15 CEUs per day. A delivery rate of 15 CEUs per day could be handled by a single RTCH at the dump, but if this RTCH were to break down or become damaged, then a costly bottleneck in the resupply system could result. As a rule of thumb, therefore, shipping containers forward is advisable when the throughput exceeds about 30 CEUs per day and justifies having two RTCHs at the dump.

E. CONCEPT DESCRIPTION

1. The recommended concept describes procedures and equipment for handling containerized ammunition for the arrival of containers at the BTP through the issue of container contents in breakbulk form at retail supply points (ASPs, bomb dumps, or field munition dumps). The major elements of the concept are:

- Retail supply points will be established as convenient under current doctrine for handling breakbulk ammunition, and are not necessarily configured to handle containerized ammunition.
- At least one ASP will require establishment to handle containerized ammunition prior to arrival of containers. Other retail supply nodes may be configured to handle containerized ammunition if their expected throughput exceeds the contents of 15 containers per day, and should be configured to handle containers if their throughput exceeds the contents of 30 containers per day.
- Retail supply points configured to handle containerized ammunition are equipped with RTCHs and laid out to provide areas for offloading and storing full containers, unstuffing containers, and storing and loading empty containers for retrograde.
- Incoming containers will be loaded on transporters and cleared from the BTP as rapidly as possible; an element of the CSSE responsible for controlling all containers in the AOA will operate a control point in the BSA and direct transporters with ammunition containers to an ASP.
- At the ASP, incoming transporters will be directed to the container offloading site at the ASP or, if possible, sent directly to a forward bomb or ammunition dump configured to handle containers.
- Once containers reach their destination, they will be unstuffed and retrograded as soon as practical.

F. CONCLUSIONS

1. The proposed concept can be fully implemented using current FLS equipments:

- The MK48/MK14 is used to transport containerized ammunition forward and retrograde empty containers.
- The LACH is used to load/offload the MK48/MK14 at the BTP (LACHs may not be required if port facilities or an ELCAS are available).
- The RTCH is used to handle containers at ASPs and dumps configured to handle containerized ammunition; container handling tasks include loading or offloading containers from the MK48/MK14 and moving containers to and from storage and unstuffing sites.
- The 4K RTFL is used to unstuff containers and handle breakbulk ammunition; breakbulk handling tasks include moving palletized ammunition to and from storage and loading it onto trucks.

2. With currently planned assets, the number of RTCHs is the most likely critical factor in limiting the Marine Corps' ability to handle containerized ammunition in the AOA. Even assuming no RTCHs are lost to mechanical failure or enemy action and none are required for other purposes, the requirement for RTCHs to handle ammunition containers could virtually equal the total number planned for a typical MAF deployment.

3. To specify changes in Tables of Organization and Tables of Equipment, the Marine Corps will have to address issues beyond the scope of this study to determine:

- Requirements for handling containers other than those containing ammunition.
- Whether sustaining or intense ammunition consumption rates should be used for planning MHE requirements.
- What percentage of the ammunition resupply requirements will be delivered to the beach in ISO containers.
- Planning factors for equipment availability due to mechanical failures and enemy action.
- Planning factors for the numbers of hours in a workday for both personnel and equipment.

4. Several items of equipment are worthy of further analysis and testing as offering improved efficiencies over current FLS components. These items are:

- Flat Racks - an alternative to the ISO container offering more efficient use of space on container ships and relative ease for unstuffing and retrograding.
- Shooting-boom Forklift - an alternative to the 4K RFTL offering 2 or 3 times the productivity for unstuffing ISO containers and the ability to unstuff containers without offloading them from the MK48/MK14.
- Self-Loading Container Hauler - an alternative to the MK48/MK14 container hauler that can pick up and drop off containers by itself, thereby reducing requirements for the RTCH at ASPs and allowing delivery of containerized ammunition to small dumps or units having no RTCH assets.
- Slip Sheet Ammunition Handling System - a packaging system that allows rapid removal of ammunition from ISO containers.
- Straddle Carriers - an alternative to the LACH for offloading landing craft, an alternative to the RTCH for container handling at ASPs, and an alternative to the MK48/MK14 for transporting containers over short distances.

5. Small and intermediate sized containers are not an attractive means for routine transport of ammunition to user units. However, this will not preclude the use of such containers for some emergency and/or special operations. While the use of these containers places an additional burden on the logistics system to stuff, unstuff, and retrograde the smaller containers, limited use of small containers for emergency ammunition re-supply by helicopter, for example, appears to be attractive.

II. OVERVIEW

A. GENERAL

This chapter describes the approach of the study, identifies factors bearing on the study, presents the general assumptions and operational parameters/planning factors used in the analysis, and briefly portrays the baseline ammunition support system for Marine Corps operating forces in an AOA.

B. TASKS AND APPROACH

The majority effort addressed the following four analytical tasks, as specified by the Marine Corps:

1. Task 1 - Develop Concepts for Containerized Ammunition Support For a MAF and a MAB From Initial Mount-out Through Subsequent Operations Ashore During the Midrange

- Emphasize system procedures and not hardware.
- The Marine Corps has new containers and equipment coming on line. Look at how these items can best be used.
- Develop the interconnecting linkages between the big pieces of the existing equipment/system (i.e., interface/linkage between FLS components and containers in general).
- Look at state-of-the-art equipment but, again, primary emphasis is on the effective and efficient use of what the Marine Corps already has or will have on the shelf.

2. Task 2 - Recommend Priorities of Tasks to be Accomplished to Alleviate Deficiencies

- Some of the types of questions that should be considered are:
  - -- What are the equipments and procedures currently possessed by the Marine Corps?

-- What is required to accomplish the task?

-- What is the impact on organizational structure?

- When these are determined, what is the recommended priority to alleviate deficiencies noted?

3. Task 3 - Recommend Priorities of Functions During an Amphibious Operation

- Some of the types of questions that should be considered are:

  -- Are there special dunnage and restraint systems that should be considered?

  -- Where should containers be stripped?

  -- How can containerization be effectively used to support the AE?

  -- How far forward should containers be moved?

  -- Should large ISO containers be stripped in the CSSA and the contents restuffed in smaller containers for movement forward?

- Emphasis should be placed on rapid support in a mobile environment as well as survivability considerations.

4. Task 4 - Identify and Prioritize Ammunition Containers Required During the Landing of the Assault and Assault Follow-on Echelons When Considering the Assault and Sustained Rates and Recommend Marshaling Techniques and Container Identification Control

- Although the Marine Corps is vitally interested in the movement of supplies and equipment from their source to the objective area and from ship to shore, of paramount importance is, "What happens after it arrives on the beach?" Study efforts should primarily be directed in this area.

- Emphasis should be placed on the development of procedures and the interconnecting linkages of the big pieces of the existing system.

Based on the interrelated nature of these tasks, the tasks were not addressed sequentially, but were considered in parallel for specific force levels (e.g., a MAF) engaged in amphibious operations in an AOA. Each of the specific points or questions listed above under each task statement are answered in the development and description of the concepts presented.

Prior to development of the containerized ammunition support concepts for MAF and MAB operations in the midrange time frame, it was necessary to establish the organization and equipment of the operating forces, the buildup ashore of those forces, ammunition resupply requirements, and other parameters essential to the analytical process. In all cases, the sources used were those directed or approved by the Marine Corps study sponsor. Further, the methodologies that were used to develop the concepts presented were such that sensitivity analyses could be applied to determine the influence of selected input conditions on study results.

C. FACTORS BEARING ON THE STUDY

Marine Corps guidance for the conduct of the study included the following major points:

- Operational concepts must be compatible with current Marine Corps doctrine, practice, and plans for logistical and combat service support of both ground and aviation units.
- The study will consider only that doctrine, practice, or equipment in being now or which will be implemented by 1995.
- Materiel requirements to support containerized ammunition must be determined.
- The study should identify the impact that containerized ammunition might have on units that have the mission to receive, store, and issue ammunition.
- Concepts that necessitate increases in number of personnel or changes to force structure will be avoided unless no reasonable alternatives exist.
- The study will be coordinated with the U.S. Navy regarding Class V(A). (See Appendix I.)

While forces, planning factors, and the implementation details for the FLS are constantly subject to change, every effort has been made to use and reflect data from the most recent available references and planning documents.

D. GENERAL ASSUMPTIONS

In addition to the guidelines above, the Marine Corps set forth the following four assumptions to provide a framework for the analysis:

- The mission of the Marine Corps, as outlined in the Marine Corps Long-Range Plan (MLRP), will remain substantially the same.
- A significant amount of all classes of supply will be containerized in future midrange operations.
- Reasonable safety and human factors considerations will be provided for in the containerization process.
- The Marine Corps will continue to have a capability to handle breakbulk ammunition/cargo.

As a result of discussions with the study sponsors, the following additional assumptions were added to the above list:

- Palletized unit loads[1] will be used to pack standard ISO containers when such containers are used for intermodal shipment of ammunition. (The significance of this assumption is that the basic entity for configuring ammunition loads will be the wooden or metal pallets or skids that are currently used for unitizing various types of ammunition and that are expected to still be in use through the midrange time period.)
- The AOA will be an isolated area without permanent port facilities; the amphibious operation may be opposed. (The significance of this assumption is that it serves to establish the most severe logistic challenge, i.e., the "worst case," with resupply over the beach in a logistics over the shore (LOTS) operation.)

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[1] A "palletized unit load" is defined in JCS Pub 1 as a "quantity of any item, packaged or unpackaged, which is arranged on a pallet in a specified manner and securely strapped or fastened thereto so that the whole is handled as a unit." For example, in the context of this study, palletized unit loads of Class V(W) are those depicted in the Unit Load Index for Marine Corps Class V(W) Material [Ref. 1].

E. OPERATIONAL PARAMETERS AND PLANNING FACTORS

The study is focused on the actions required to enable the Marine Corps to deal with containerized ammunition in an AOA from the beach inland.

The analysis is predicated on notional MAF and MAB task organizations employed under conditions as presented in the current Marine Corps Mid-Range Objectives Plan (MMROP, FY 84-93) [Ref. 1] and, as appropriate, in the Marine Corps Scenarios (MARCORS) IA, IV, and V [Refs. 2, 3, and 4]. The composition of these forces as it pertains to the purposes of this study is presented in Chapter III.

Determination of ammunition consumption is based on the USMC intense and sustained rates for ground ammunition requirements, as derived from the MAGTF Lift Planning Model [Ref. 5] and on U.S. Navy-approved rates for aviation ordnance [Ref. 6]. Daily tonnages of expenditures for various ammunition categories are given in Chapter IV.

The concepts of containerized ammunition support are developed initially for a MAF-sized operation and extrapolated as necessary to ascertain how the concepts might have to be modified for a MAB. Also, the period of employment ashore is assumed sufficiently long to require resupply from CONUS or other points of origin. The maximum inland penetration distance of combat units is considered to be on the order of 100 miles, thus necessitating establishment of areas for combat service support elements (CSSEs) away from the immediate beach landing sites.

F. BASELINE AMMUNITION LOGISTIC SUPPORT SYSTEM

The current Marine Corps ammunition logistic support structure, concepts for ammunition support, attendant ammunition support organizations, and techniques of employment are designed for supporting the conduct of amphibious operations under limited and general war conditions anywhere in the world. The Commandant of the Marine Corps is responsible for the overall management of Marine Corps ground force ammunition worldwide. The Navy

is responsible for the procurement and management control of Class V(A) ammunition. Class V(A) is distributed by the Navy to CINCPACFLT, CINCLANTFLT, and CINCUSNAVEUR, and pre-positioned by each FLTCINC for the Navy and Marine Corps forces at various overseas locations in support of FLTCINC OPLANS. In this study, Class V(A) is considered only from the point at which it enters the logistic system of Marine Corps operating forces in an AOA.

The Class V(W) stocks for support of FMF Atlantic (FMFLANT) contingency operations for the first 60 days are apportioned as follows:

Location	Category
Marine Corps base/air station, East Coast	Basic allowance items
Amphibious ships and Marine Corps base/air station, East Coast	Operating stocks, landing force operational reserve materiel (LFORM), and air alert force (AAF) items
Naval weapons stations, East Coast	Mount-out stocks
Overseas Naval magazines	Pre-positioned war reserve materiel stocks (PWRMS)

The percentage of the total Class V(W) requirements in each of the above categories will vary depending on the situation, but it is expected that at least half of the stocks will be in the form of overseas PWRMS.

Class V(A) is managed by the Navy and will be similarly apportioned. Class V(A) will be issued to the FMF operating forces by the Navy on a "fair share" basis based on the number, types, and missions of the aircraft that comprise the aviation combat element (ACE).

Class V(A) is pre-positioned at overseas locations that are not capable of outloading containerized ammunition. The Navy is programmed to package, handle, store and, ship Class V(A) in metal pallet configurations, aboard breakbulk ships through the 1985-1995 timeframe. The 30 day initial supply of Class V(A) to support amphibious operations of the MAB or MAF are stored overseas at Naval sites that are not equipped with container throughput equipment. Naval amphibious ships (LKA, LPH, LHA, LPD, and

LST), and ammunition ships (AE, AOE) are configured to handle break bulk ammunition only. Only one port in the United States is capable of outloading containerized ammunition.

A simplified representation of the baseline network for ammunition supply/resupply is presented in Figure II-1. The origination points are either in CONUS or at locations outside of CONUS such as the overseas Naval magazines; the debarkation point(s) (in the absence of permanent port facilities) could be a causeway, floating pier, or a portion of a colored beach area designated for offloading Class V supplies. The palletized ammunition loads will generally be transported from the beach to an ammunition storage area within an established CSSA, with further transshipment to ASPs, when established. Issue of ammunition is normally by supply point distribution in which case unit motor transport comes to the ammunition area or ASP to draw ammunition and return to the unit. An alternative method is unit distribution, in which case service support motor transport would deliver ammunition directly to selected units. Both methods may be employed simultaneously and are illustrated in Figure II-1.

Figure II-1 depicts the condition that has evolved over time with the landing of personnel and equipment ashore to handle and move ammunition to using units. In the initial stages, during the landing of the ground combat element (GCE) of the assault echelon (AE), the Class V(W) will be carried by individuals and the organic transport of the using units. During this same period, portions of the ACE will arm/rearm on the decks of amphibious assault ships (i.e., LHA/LPH) and receive Class V(A) from the Navy ship(s) designated to support the ACE.

As soon as possible, an ammunition storage area/ASP is established and built up over time by the supporting CSSE to ensure a level of ammunition sufficient to support combat operations. Initially, the stockages are primarily Class V(W), with Class V(A) phased ashore as ACE units become operable at ground bases within the AOA.

Subsequent to the landing of the AE and AFOE, at a time established by the commander, resupply from the source will be established to maintain ammunition stockage quantities at prescribed levels.

Chapters III through VI establish the basic foundation for the containerized ammunition concepts developed in Chapters VII and VII; Chapter III presents the notional task organizations for a MAF and a MAB, to include a discussion of the MPS program; Chapter IV provides a summary of postulated ammunition consumption for these forces, principally to gain insight into high usage categories and nominal distribution patterns; Chapter V discusses the efficacy of various components of the FLS relative to containerized ammunition support; and Chapter VI summarizes the state of the art regarding available developmental items that have applicability in implementing a containerized ammunition concept.

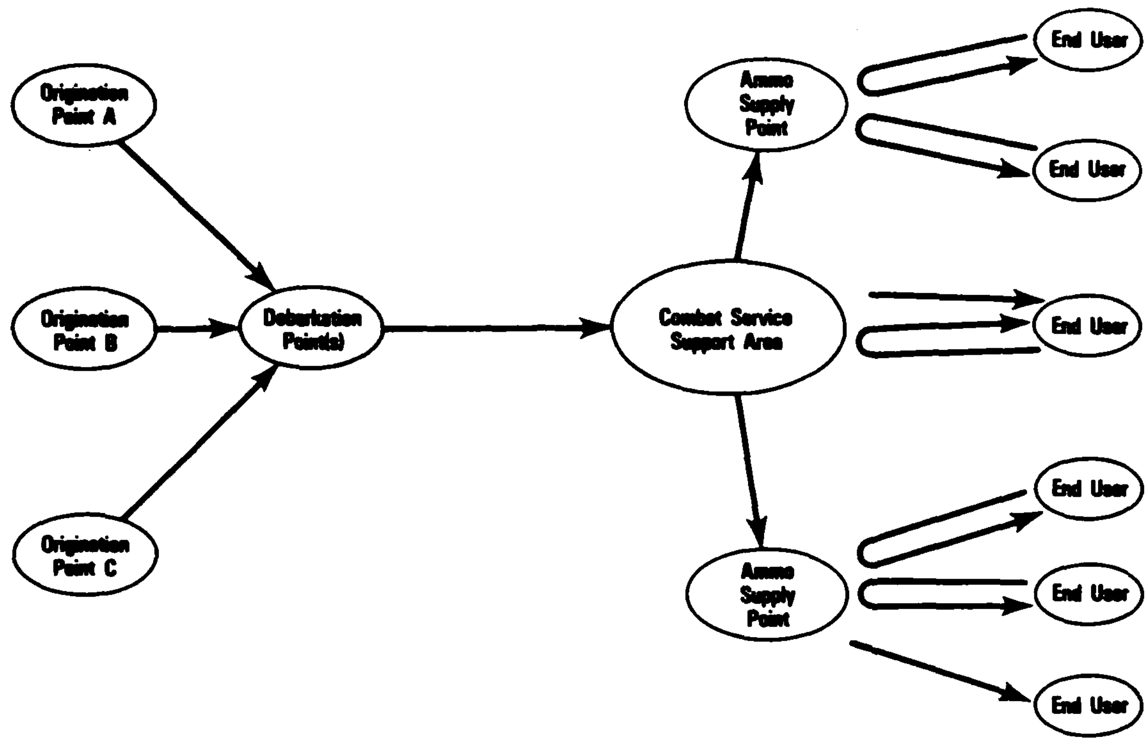


FIGURE II-1.
AMMUNITION SUPPLY/RESUPPLY NETWORK

III. NOTIONAL TASK ORGANIZATIONS

A. GENERAL

The development of a viable ammunition support concept is largely dependent on an understanding of the organization and weapon systems to be supported. This chapter discusses basic USMC organizations and equipments, to include transportation assets and MHE.

Fleet Marine Forces are designed for task organization into integrated air-ground teams known as Marine air-ground task forces (MAGTFs). All MAGTFs, regardless of size or specific composition, contain four basic elements as shown in Figure III-1. There are three different size MAGTFs; the MAF, the MAB, and the Marine amphibious unit (MAU). This study addresses the MAF and the MAB as the basis for the containerized ammunition support concept. Because of the MAU's comparatively limited sustainability, the likelihood of containerizing its ammunition supply is significantly less than it is for a MAF or MAB.

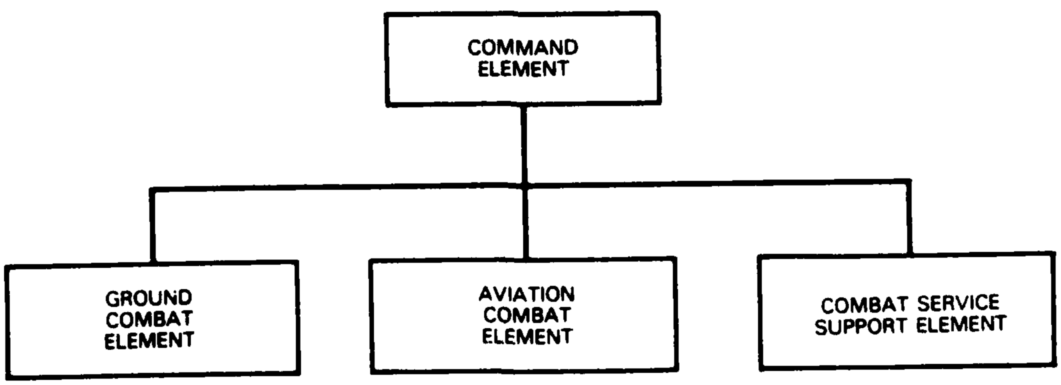


FIGURE III-1.
BASIC ELEMENTS OF MARINE AIR-GROUND TASK FORCES

B. NOTIONAL MARINE AMPHIBIOUS FORCE (MAF)

1. Description

The MAF, the largest and most powerful MAGTF, is organized as shown in Figure III-2. Since MAGTFs are task organized for specific missions, the actual composition of a given MAF might vary somewhat at the unit level; however, the basic structure remains as shown.

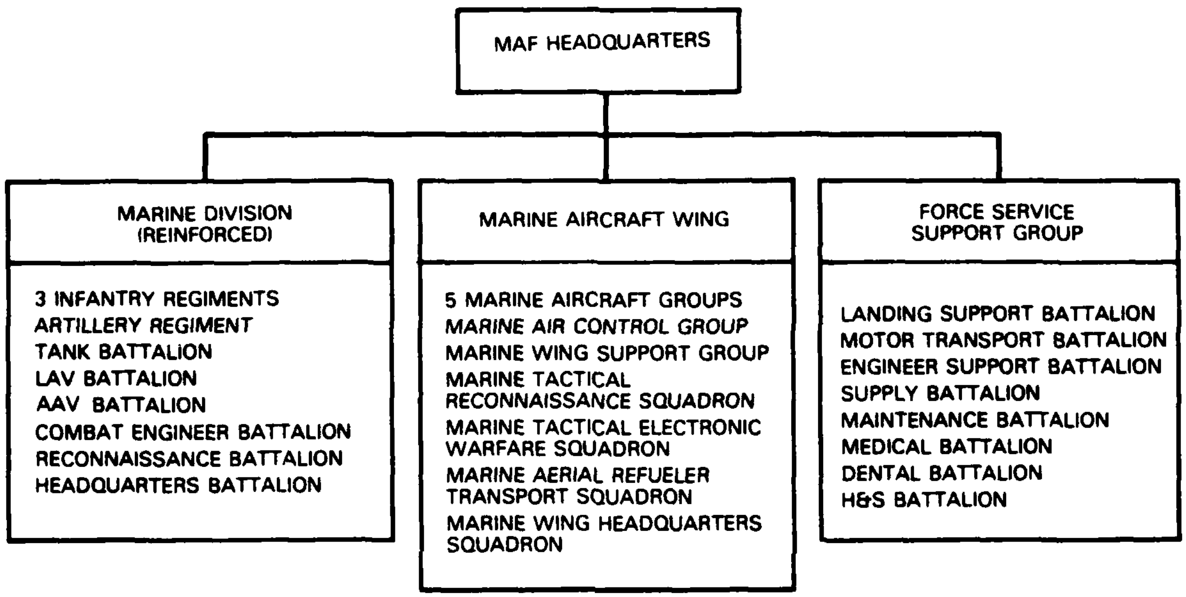


FIGURE III-2.
NOTIONAL MAF ORGANIZATION

A MAF normally contains a reinforced Marine division, a Marine aircraft wing, and a FSSG and is commanded by a Major General or Lieutenant General, depending on its exact size and mission. The MAF commander is responsible for the task organization of the force and for the temporary reassignment of units for specific operations or exercises.

Total personnel strength in the MAF is about 55,000. Approximately 34,950 personnel are in the primary attack force (or AE), 10,740 make up the AFOE, and about 9,310 constitute the fly-in echelon (FIE).

2. Major MAF Elements

The major elements of the MAF shown in Figure III-2 can be related to the generic MAGTF organization as follows:

- MAF headquarters ⟶ Command elements
- Marine division (Rein) ⟶ Ground combat element (GCE)
- Marine air wing ⟶ Aviation combat element (ACE)
- FSSG ⟶ Combat service support element (CSSE)

The MAF headquarters provides the overall control and organization of the force. Usually this element contains the MAF commander, parts of his staff, and detachments from subordinate units that tend to support the force as a whole. Examples of the functions performed by such detachments include prisoner interrogation, force reconnaissance, photographic interpretation, and sensor control/management.

Although the GCE can vary in size from a division (minus) to several reinforced divisions, it is most often considered to be a single Marine division (rein). Nominally, this reinforced division consists of three infantry regiments, one artillery regiment, and several combat support battalions.

The preponderance of the GCE's firepower is located in the artillery units and in the tank and light armored vehicle (LAV) battalions. The assault amphibian battalion provides much of the transportation for the initial surface assault forces (e.g., infantry), and the combat engineer battalion provides overall engineering support (such as minefield sweeping/clearing and essential vertical construction) to the other division units, as required. Ground reconnaissance functions are performed by units of the reconnaissance battalion, which are normally attached to the forward companies of the infantry regiments. Control and administrative services for the GCE are provided by the headquarters battalion.

The ACE nominally has four to five Marine aircraft groups (MAGs), a Marine air control group (MACG), a Marine wing support group MWSG, and the Marine wing headquarters squadron (MWHS). MAGs are of two types--fighter/attack and helicopter. The former are commonly designated MAG(VF/VA) while the latter are designated MAG(VH).

The MACG contains headquarters, communications, air control, air support, and air traffic control squadrons as well as the air defense units of

The MACG contains headquarters, communications, air control, air support, and air traffic control squadrons as well as the air defense units of the MAW. In particular, the air defense units are the light anti-aircraft missile (LAAM) battalion and the forward area air defense (FAAD) battery. Logistics support of the MAW is provided by the MWSG, wing engineer, and wing transportation squadrons. Other squadrons within the MAW provide tactical reconnaissance, electronic warfare (EW), and refueling support for all units of the wing.

The preponderance of Combat Service Support for the MAF is found in the battalions of the CSSE. The landing support battalion provides the command structure, personnel, and specialized equipment that form the basis for effective management of breakbulk cargo/container throughput during operations at ports, railways, airfields, and beaches. Medium and heavy motor transport support for MAF units comes from the motor transport battalion, and general engineer support (e.g., bridge equipage, water supply, repair of runways, expeditionary airfield (EAF) installation) is the responsibility of the engineer support battalion. The supply battalion is organized into companies based on the classes of supply being handled; supply dumps for various classes of supply are built up as cargo is brought ashore. The maintenance battalion provides intermediate level maintenance support for all Marine Corps-furnished ordnance, engineer, transport, communications, electronics, and supply equipment within the MAF. Medical, dental, and headquarters functions are provided, respectively, by the medical, dental, and headquarters and service (H&S) battalions of the CSSE.

3. MAF Weapon Systems

Table III-1 details the major weapon systems in the GCE of a notional MAF. Because of the task-organized nature of the MAF, actual weapon quantities are not always the same as shown here, but may vary slightly with the specific mission at hand. The largest expender of artillery ammunition is the large number of 155-mm howitzers. The 8-inch howitzer accounts for

the remainder of the artillery firepower. Other indirect-fire weapons found in the MAF include the 81-mm and 60-mm mortars. (The 105-mm howitzer has been retired from active Marine Corps forces.)

TABLE III-1. MAF GCE WEAPON SYSTEMS

System	Quantity
Artillery	
155-mm howitzer	108
8-inch howitzer	12
Mortars	
81-mm mortar	72
60-mm mortar	81
Tanks	
M60 w/105-mm gun	70
or M1	58
Amphibian Assault Vehicles	
LVT	208
Light Armored Vehicles (LAV)	
LAV	110
Rocket/Missile Launchers	
Dragon	288
TOW	144
Small Arms	
MK19	330
SMAW	189
M2 MG	435
M60 MG	601
Personal weapons	

Tank quantities shown for the M60 and the M1 are mutually exclusive. A MAF will contain either 70 M60 tanks or 58 M1 tanks, not both. Changes to tank ammunition requirements that would result when the M1 becomes the Marine Corps main battle tank are discussed in Chapter IV. The IOC for the M1 is 1990.

Other MAF combatant vehicles include the assault amphibian and light armored vehicles. The primary antitank systems are the Dragon and TOW missiles, which are found in the antitank company of the tank battalion. In addition to these major ground weapons, the MAF also has a large number of automatic rifles, machine guns, and personal weapons.

Major weapons in the MAF ACE consist of the aircraft and anti-air warfare launchers shown in Table III-2. Of these aircraft, the large expenders of ordnance are the fixed-wing jet aircraft, primarily the AV-8, F-4/FA-18, and the A-6E. The EA-6 is used for electronic warfare and the RF-4B is a reconnaissance version of the F-4. Neither of these type aircraft normally expend large amounts of ammunition. Similarly, the TA4 trainer, OV-10A observation aircraft, and KC-130 cargo aircraft are not large consumers of ammunition. Cargo helicopters (i.e., CH-46s and CH-53s) generally expend only gun ammunition while the UH-1N can fire certain rockets/missiles as well. The AH-1T attack helicopter is capable of firing both a 20-mm gun and assorted rockets/missiles.

Hawk missiles are among the largest ordnance items in the Marine Corps inventory, measuring 215 inches long and weighing approximately 3,300 pounds. A combined Stinger/Redeye quantity is shown (Table III-2) since, for the near future, both will be in the field simultaneously.

TABLE III-2. MAF ACE WEAPON SYSTEMS

System	Quantity
Fixed-wing aircraft	
AV-8	100
F-4/FA-18	72
A-6E	40
EA-6	15
RF-4B	7
TA4/OA4	12
OV-10A	12
KC-130	24
Rotary-wing aircraft	
CH-46E	156
CH-53D	80
CH-53E	32
UH-1N	24
AH-1J	72
Anti-air warfare launchers	
Hawk	24
Stinger/Redeye	150

4. MAF Motor Transport

As part of the FLS, the Marine Corps is standardizing its vehicle fleet. Common chassis and power units are used where possible to reduce maintenance times/costs and to enhance interoperability. The location and approximate quantities of motor transport assets throughout the MAF are shown in Figure III-3 [Ref. 7].

ASSET TYPE	NUMBER BY UNIT																				
	GCE								ACE				CSSE								
	HQ BN	INFANTRY REGT	ARTY REGT	COMBAT ENGR BN	RECON BN	TANK BN	AAV BN	LAV BN	MACG	MWSG	MAG (VF/VA)	MAG(VH)	H&S BN	SUPPLY BN	MAINT BN	LANDING SPT BN	ENGR SPT BN	MOTOR TRANS BN	MEDICAL BN	DENTAL BN	TOTAL
Trucks																					
HMMWV, Cargo, M998, 5/4 ton	134	366	347	37	48	49	25	35	178	61	36	24	64	10	17	32	65	28	7	4	1567
HMMWV, Tow, M1045, 5/4 ton		72				72									2						146
HHMTT, 5-ton cargo	131	9	324	10	8	38	17	10	158	104			18	12	36	10	18	117	10		1030
LVS-MK48 front power unit			4	3						27					9		12	184			239
LVS-MK14 container hauler										13								132			145
LVS-MK17 dropside cargo																		41			41

SOURCE: U.S. Marine Corps Field Logistics System Equipment Distribution, 30 Dec 83

**FIGURE III-3.
MAF TRANSPORTATION ASSETS**

The high-mobility multipurpose wheeled vehicle (HMMWV) replaces the M151 jeep and 1/4-ton trailer, the M561 Gamma Goat, and the M792/M718A1 ambulances. Although a versatile vehicle, it is not useful for moving substantial amounts of heavy ordnance. However, it may be useful for transporting limited amounts of small arms ammunition, pyrotechnics, and demolitions. In such a role, the HMMWV might aid in the resupply of infantry units and some of their attachments.

The heavy high-mobility tactical truck (HHMTT) replaces 5-ton and 2-1/2-ton trucks currently in the FMF and is used to move palletized ammunition from ammunition dumps to using units, and to pull bomb trailers from bomb dumps to the flight line.

Other major ammunition transporters include the LVS-MK48/MK14 container hauler combination and the logistical vehicle system (LVS)-MK48/MK17 dropside cargo combination. These vehicles consist of a common MK48 front power unit (FPU) and a mission-specific rear body unit (RBU). The MK14 will be the primary transporter of 8'x8'x20' ammunition containers in the AOA, once containerized cargo is brought ashore. MK17 dropside cargo RBUs (which have an onboard crane) can accommodate breakbulk cargo and small or intermediate containers.

For GCE units, the most useful vehicle for transporting ammunition is the HHMTT (see Figure III-3). Within the artillery regiment and the tank battalion, some HHMTTs are dedicated to an ammunition support role. However, as mentioned earlier, the HHMTT can accommodate only palletized ammunition. For all practical purposes, within the GCE there is no capability to transport 20-foot ammunition containers.

Within the ACE there is a palletized ammunition transport capability and a limited ability to transport containers. This limited ability could be provided by the 13 MK14 container haulers located in the MWSG. However, these 13 units are available to handle all classes of supply, not just Class V.

Most of the transport assets for hauling 20-foot containers are found in the CSSE. In particular, the Motor Transport Battalion will contain approximately 91 percent of all MK14 container haulers allocated to the MAF.

The above vehicles are all part of the motor transport subsystem of the FLS and are discussed in more detail in Chapter V.

5. MAF Materials Handling Equipment

MHE for MAF-sized organizations is shown in Figure III-4 [Ref. 7] and consists mainly of cranes and forklift trucks. Although the 30-ton rough terrain crane (RTC) is used in marshaling yard operations, it is limited to handling empty or lightly loaded containers due to low boom ratings at

shallow angles. The 7-1/2-ton crane is not useful for handling large containers, but is used extensively in MAG bomb dumps for lifting and handling munitions.

MHE TYPE	NUMBER BY UNIT*										TOTAL
	GCE					ACE	CSSE				
	ARTILLERY REGIMENT	TANK BATTALION	COMBAT ENGINEER BATTALION	AAV BATTALION	LAV BATTALION	MARINE WING SUPPORT GROUP	H&S BATTALION	MAINTENANCE BATTALION	LANDING SUPPORT BATTALION	ENGINEER SUPPORT BATTALION	
CRANE, RT, 30 ton			4			6		1	18	7	36
CRANE, WHEEL MTD 7½ ton (SP and RT)						25**			6**	12**	43
TRUCK, FORKLIFT, RT, 10,000-lb	1		8	1		17	6	1	15	15	64
TRUCK, FORKLIFT, RT, 6,000-lb		1	8		1	56	35		12		113
TRUCK, FORKLIFT, RT, 4,000-lb	41		5			20	25	1	24		116
ROUGH-TERRAIN CONTAINER HANDLER									6		6
LIGHTWEIGHT AMPHIBIOUS CONTAINER HANDLER									12		12

*SOURCE: U.S. Marine Corps Field Logistics System Equipment Distribution, 30 Dec 83
**SOURCE: N-Series Table of Equipment (N-8744, N-3240, N-3250)

FIGURE III-4.
MAF MATERIAL HANDLING EQUIPMENT

Forklift trucks are the most numerous pieces of MHE in the MAF. The 10K RTFL is a diesel-powered, four-wheel-drive, rubber-tired tractor with articulated steering. It can operate in up to 5 feet of surf and is primarily used in handling of shipping frames and other components of the FLS. The 6K RTFL can also operate in up to 5 feet of surf and is similar in design to the 10K vehicle but has less weight-lifting capability. The 4K RTFL is a pneumatic-tired, helicopter-transportable vehicle for direct support of combat, combat support, and combat service support units. It is well suited for unstuffing 8'x8'x20' containers in the AOA. In the artillery regiment, the 4K RTFL also serves as an auxiliary prime mover for the M198 howitzer.

Handling of large loaded containers is to be performed by the 50,000-pound RTCH and the lightweight amphibious container handler (LACH). The RTCH is the principal means in the FLS for container handling in marshaling and storage area applications.

LACHs require a prime mover, such as a medium crawler tractor, and operate by straddling the container to lift and move it. They can function in up to 5 feet of surf and are primarily used to offload containers from landing craft and place them on the ground or on container haulers.

All of the above items are part of the materials handling equipment subsystem of FLS and are discussed in more detail in Chapter V.

Also, within the ACE, there are approximately 112 CH-53 cargo helicopters that can handle QUADCONs or palletized ammunition. While these helicopters may be useful in emergency resupply of such ordnance, their primary mission is movement/transport of all classes of supply with an additional mission of troop movement.

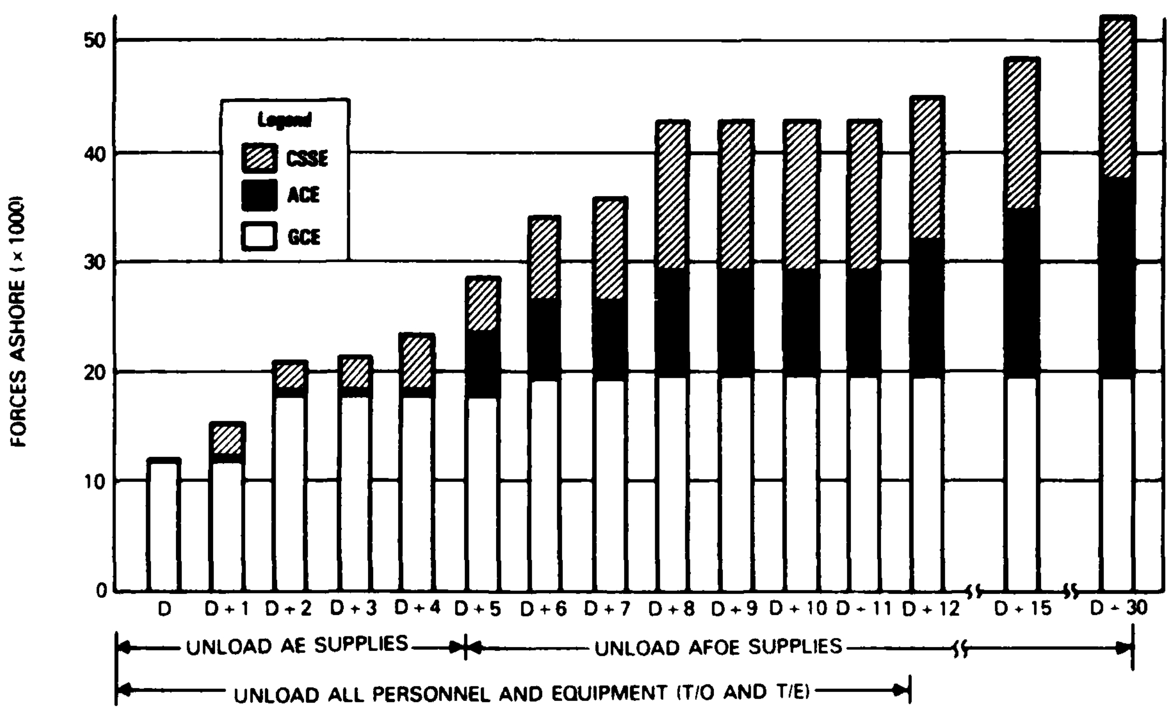
6. MAF Buildup Ashore

Figure III-5 details the force buildup ashore, by major elements, for a MAF. This chart was constructed using the landing priority table and troop list data shown in MARCORS-1A to estimate unit arrival times. Table C-2 of Appendix C provides the summarized data used to construct Figure III-5. Figure III-5 (and Table C-2) should not be interpreted as absolutes; rather, they reflect approximate numbers of personnel ashore. As such, they are useful in illustrating the early buildup of ground combat units and the somewhat later phasing of the aviation units. The darkly shaded areas of the chart indicate that the buildup of the ACE is small through D+4. Air units arriving during this period are HAWK missile batteries, Marine air support squadron elements, and a forward anti-air defense battery. On or about D+5 the first MAG(VH) comes ashore, and the second arrives on D+8. Transition-ashore times for MAG(VA)s are not specified in the MARCORS. For planning purposes, the study team assumed that one MAG(VA) arrived on D+12, a second on D+15, and the final one on D+30.

Naval support forces are included in the CSSE buildup ashore, which is indicated by the cross-hatched portions of the chart. Through D+2, the CSSE consists largely of landing support battalion, supply battalion, and other beach party elements. Elements of the motor transport battalion are ashore by D+3, and engineer support battalion detachments follow around

D+4. The H&S battalion, CSSE, is completely ashore by D+6. The maintenance battalion, medical battalion, dental battalion, and remaining supply battalion elements complete most of the CSSE buildup by D+8. Final elements of the Navy's mobile construction regiment move ashore about D+30.

During the force buildup, supplies are offloaded (commensurate with available MHE) to ensure continuing support for the advancing combat and combat support units. Thus, AE supplies (15 days of supply) are in breakbulk form or in small or intermediate containers; AFOE supplies (45 days of supply) also include large ISO containers. The MMROP provides planning guidance for this offload, as shown at the bottom of Figure III-5, i.e., that AE supplies are offloaded by D+5 and AFOE supplies between D+5 and D+30. Thus, by D+5, one or more CSSAs should be established with supply points for various classes of supply.



NOTES: (1) Consistent with MMROP AND MARCORS.
(2) Assumes one VA MAG arrives on each of the following days: D + 12, D + 15 and D + 30, and one VH MAG arrives on D + 5 and D + 8.
(3) CSSE segments include Naval support personnel.
(4) GCE segments include command element personnel.

FIGURE III-5.
MAF BUILD-UP ASHORE

7. MAF Support Organizations

Ammunition supply support organizations for the notional MAF are shown in Figure III-6. The Marine division truck company of the headquarters battalion has approximately 100 5-ton trucks. In an emergency, some of these vehicles could be tasked to assist in the movement of breakbulk ammunition to division units, but they are not available for routine ammunition supply/resupply. Within the artillery regiment, there are 148 5-ton trucks and 5/4-ton trailers dedicated for ammunition-related tasks. Similarly, the tank battalion has 24 dedicated 5-ton ammunition vehicles.

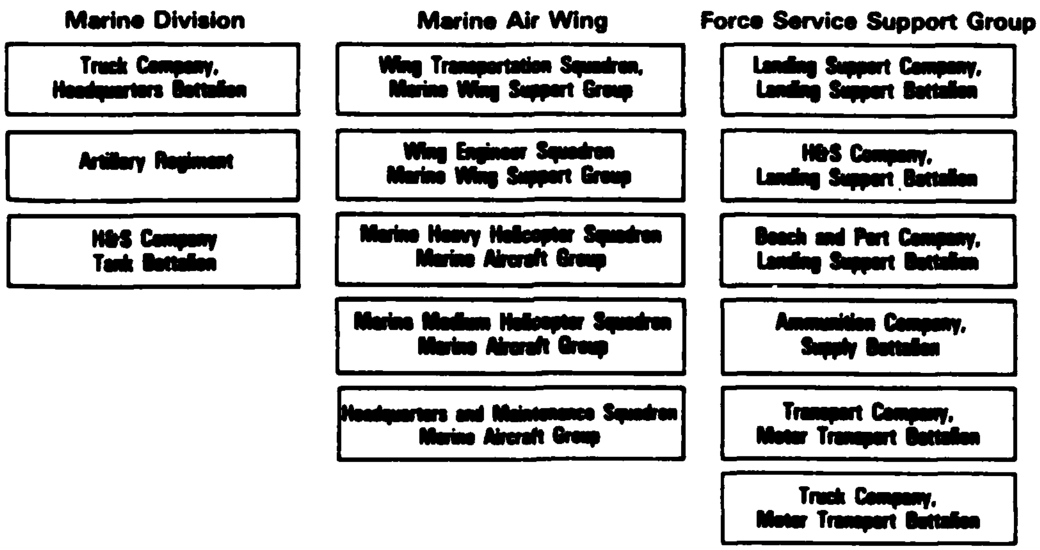


FIGURE III-6.
MAF AMMUNITION SUPPORT ORGANIZATIONS

For the Marine Air Wing, heavy payload vehicles are required to transport bulk palletized Navy ammunition from: (1) the beach to the FSSG; (2) the FSSG to theater air base bomb dumps, and (3) theater air base bomb dumps to air facility forward site bomb dumps. The FSSG responsibility for transporting bulk ammunition extends from the beach to the CSSA and then to the theater air bases. The MWSG responsibility for transporting bulk ammunition extends from the theater air base bomb dump to the forward air base "mini" bomb dumps. The MAG (H&MS) responsibility for transporting assembled chemical, nuclear, and conventional ammunition extends from the air base bomb dump to the air base flight line area. The MWSG may augment this function provided MWSG operators are explosive driver licensed, and are qualified and certified in writing by the MAG (H&MS) to perform munitions functions in accordance with applicable Naval Directives. MWSG operators must be Personnel Reliability Program (PRP) certified by the MAG (H&MS) in the case of chemical and nuclear weapons. The resupply of bulk ammunition from the FSSG to the air base is normally conducted at night so as not to interfere with peak air base operations during daylight hours and to reduce the risk of enemy air attack. The resupply of assembled ammunition from the MAG (H&MS) bomb dump to the flight line area is a 24 hour per day operation with peak activity occurring during daylight hours.

Many ammunition supply support functions are performed by elements of the battalions of the CSSE. The landing support battalion (LSB) provides much of the specialized MHE and personnel required for the management of breakbulk and containerized cargo for all classes of supply. The landing support company of the LSB is responsible for locating and establishing interim multiclass dumps and controlling the landing beaches. Engineer equipment support and minimum transportation are provided to the landing support company by the H&S company of the LSB. The beach and port company of the LSB directs beach, railhead, airhead, and cargo terminal operations.

Handling and management of containers is the responsibility of the beach and port company, which provides personnel and equipment for supply movement within dumps and depots.

Medium, heavy, and marginal terrain transport augmentation for the MAF is provided by the motor transport battalion, which contains the primary containerized ammunition hauler, the LVS-MK48/MK14.

Within the supply battalion, the ammunition company is dedicated to the receipt, storage, and issue support of all Class V items. The major elements of this company are the company headquarters, a general support ammunition platoon, two direct-support ammunition platoons, a nuclear ordnance platoon, and an explosive ordnance platoon. The ammunition platoons are composed of ammunition squads, package/helicopter support squads, and an aviation ammunition section. In MAF-sized operations, the ammunition company can organize and operate one or more ASPs in one or more CSSAs.

C. NOTIONAL MARINE AMPHIBIOUS BRIGADE (MAB)

1. Description

The MAB is the second largest MAGTF and is generally organized as shown in Figure III-7. Like the MAF, the MAB is a task organization and may be organized somewhat differently than shown here; however, the basic overall structure would remain the same. A MAB usually contains a regimental landing team (RLT), a MAG, and a brigade service support group (BSSG). Normally, a MAB is commanded by a brigadier general.

2. Major MAB Elements

The MAB GCE is a regimental landing team composed of two to five infantry battalions, an artillery battalion, and the supporting company size units shown in Figure III-7. Antitank missile assets are provided by the TOW platoon that is part of the tank battalion. Aviation support for the MAB is provided by a MAG containing fixed-wing, rotary-wing, and antiair-warfare assets. This MAG is the smallest aviation unit designed for relatively independent operations and is equipped and organized to facilitate deployment ashore as existing airfields become available or as expeditionary airfields are developed.

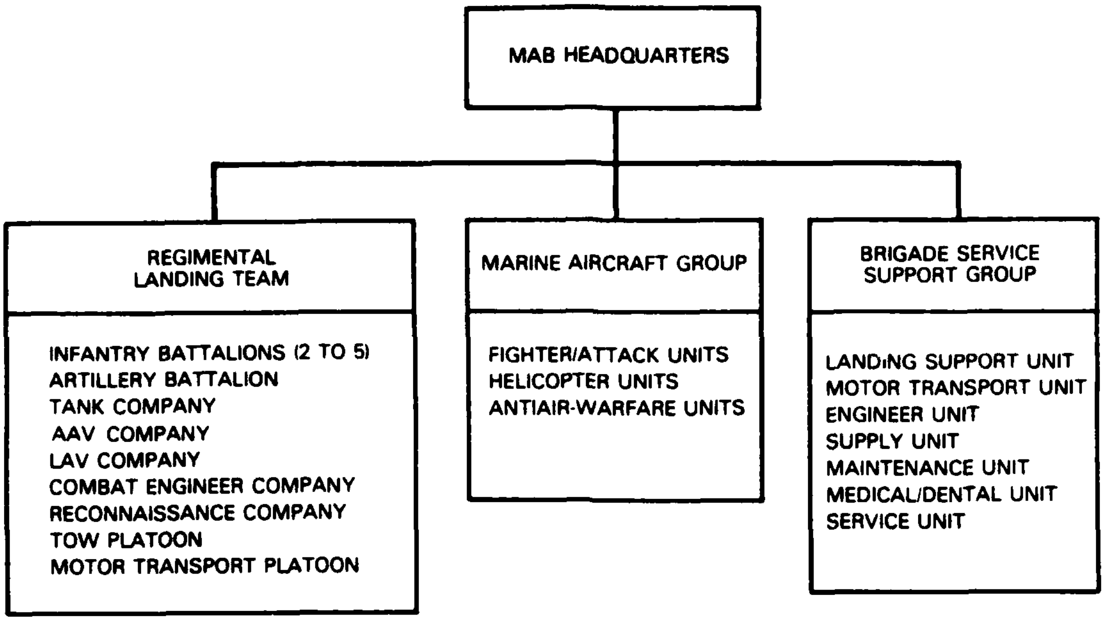


FIGURE III-7.
NOTIONAL MAB ORGANIZATION

The BSSG is *task organized* from elements of the FSSG to provide the CSS needs of the MAB for up to 30 days without resupply. The BSSG units shown in Figure III-7 perform essentially the same functions as their parent organizations in the FSSG perform for the MAF.

3. <u>MAB Weapon Systems</u>

Table III-3 details the types and quantities of the major weapon systems in the GCE of a notional MAB. As in the MAF, actual weapon quantities vary somewhat depending on the specific mission being undertaken.

TABLE III-3. MAB GCE WEAPON SYSTEMS

System	Quantity
Artillery	
155-mm howitzer	30
8-inch howitzer	6
Mortars	
81-mm mortar	24
60-mm mortar	27
Tanks	
M60 w/105-mm gun	17
or M1	14
Amphibian assault vehicles	
LVT	45
Light-armored vehicles	
LAV	38
Rocket/Missile Launchers	
Dragon	96
TOW	48
Small Arms	
MK19	110
SMAW	63
M2 MG	138
M60 MG	255
Personal weapons	

Although the weapon types are the same as those found in a MAF, the quantities found here are substantially less. Again, the systems of primary interest to this study are those that expend the most ammunition. As will be seen in Chapter IV, the howitzers account for most of the Class V(W) usage in the MAB. Class V(A) ordnance for the MAB is expended by the aircraft shown in Table III-4, primarily by the fixed-wing fighter and attack aircraft and by the attack helicopters.

TABLE III-4. MAB ACE WEAPON SYSTEMS

System	Quantity
Fixed-wing aircraft	
AV-8	40
F-4/FA-18	24
A-6E	20
EA-6	7
RF-4B	4
TA4/OA4	6
OV-10A	6
KC-130	8
Rotary-wing aircraft	
CH-46E	48
CH-53D	32
CH-53E	10
UH-1N	6
AH-1J	24
Anti-air warfare launchers	
Hawk	6
Stinger/Redeye	60

4. MAB Motor Transport

A MAB possesses the same types of motor transport assets as a MAF, but quantities and distribution are somewhat different, as shown in Figure III-8 [Ref. 7].

ASSET TYPE	NUMBER BY UNIT																
	GCE						ACE			CSSE							
	HEADQUARTERS	INFANTRY RGT	ARTY BN	RECON CO	AAV PLT	COUNTERINTELLIGENCE TEAM	AIR CONTROL SQDRN	AIR BASE SQDRN	MWSG (DET)	H&S CO	SUPPLY CO	MAINT CO	ENGR CO	MOTOR TRANS CO	MEDICAL CO	DENTAL CO	TOTAL
Trucks																	
HMMWV, Cargo, M998, 5/4 ton	15	122	37	1		5	7	10	15	17	1	3	5	24	1	1	264
HMMWV, Tow, M1045, 5/4 ton		24															24
HHMTT, 5-ton cargo	6	3	33				6		26	3		2	1	56			136
LVS-MK48 front power unit			1						8					33			42
LVS-MK14 container hauler									4					22			26
LVS-MK17 dropside cargo														6			6

FIGURE III-8.
MAB TRANSPORTATION ASSETS

5. MAB Material Handling Equipment (MHE)

Like the transportation assets, the MHE types found in the MAB are identical to those in the MAF. The locations and quantities of MAB material handling equipment are shown in Table III-9 [Ref. 5].

MHE TYPE	LOCATION BY UNIT									
	GCE					ACE	SSE			
	ARTILLERY BATTALION	TANK COMPANY	COMBAT ENGINEER COMPANY	AAV COMPANY	LAV COMPANY	DET MARINE WING SPT GRP	DET H&S BATTALION	LANDING SUPPORT COMPANY	DET ENGR SPT BN	TOTAL
CRANE, RT 30 ton			✓			✓		✓	✓	9*
CRANE, WHEEL MTD. 7½ ton (SP and RT)						✓		✓	✓	16*
TRUCK, FORKLIFT, RT, 10,000-lb	✓		✓			✓	✓	✓	✓	26**
TRUCK, FORKLIFT, RT, 6,000-lb		✓	✓			✓	✓	✓	✓	41*
TRUCK, FORKLIFT, RT, 4,000-lb	✓		✓			✓	✓	✓	✓	24*
ROUGH-TERRAIN CONTAINER HANDLER								✓		5**
LIGHTWEIGHT AMPHIBIOUS CONTAINER HANDLER								✓		4**

*MAGTF Lift Planning Data of Oct 83.
**Approximation based on 6th MAB MPS planning factors of 19 Oct 83.

FIGURE III-9.
MAB MATERIAL HANDLING EQUIPMENT

6. MAB Buildup Ashore

The MAB buildup ashore follows the same general trend as that shown in Figure III-5 for the MAF, i.e., the GCE units largely come ashore by D+2; but the ACE buildup is initially small as fixed-wing aircraft operate from airbases outside the AOA during the first days of the assault. Detachments from the BSSG land with the GCE, but the majority of the support forces come ashore some days later.

The BSSG is capable of supporting a MAB for 30 days without resupply. Current MMROP guidance states that the 15 days of supply (DOS) for the AE are to be offloaded by D+5, and the AFOE 15 DOS by D+15. Thus, all AFOE supplies for the MAB come ashore over a 10-day period (i.e., D+5 to D+15) as opposed to the 25-day period (i.e., D+5 to D+30) allowed for unloading MAF AFOE supplies. Furthermore, the current MMROP states that all MAB units are to be offloaded by D+9; 3 days earlier than the D+12 goal for unloading all MAF units.

7. MAB Ammunition Support Organizations

Palletized ammunition support for the MAB can be found in the organic assets of the regimental landing team and the MAG. The artillery battalion and the tank company have 5-ton trucks that are dedicated to performing ammunition related tasks. Helicopter units can be useful in emergency resupply of ammunition, but these units are primarily used for troop movement and emergency resupply. They are also a pooled resource and are not usually dedicated ammunition haulers. Most of the ammunition control functions are performed by the subordinate units of the BSSG. The BSSG is formed from the FSSG and may also include naval support element forces. Ammunition container handling and control functions largely are centered in the landing support, motor transport, and supply units of the BSSG.

D. MARITIME PRE-POSITIONING SHIPS (MPS) PROGRAM

1. Description

The MPS program is a permanent follow-on to the near-term prepositioning force (NTPF), which is currently in existence. The MPS program involves pre-stationing selected equipment and 30 days of supplies for three MABs near potential crisis areas. The intent of MPS is to provide "rapid pre-emptive response into an essentially benign area or rapid reinforcement of already committed forces." MPS is not intended to be the lead element of an amphibious assault.

The three permanent MPS units are designated MPS-1, MPS-2, and MPS-3. MPS-1 is made up of one AMSEA ship and three Waterman ships, MPS-2 contains five Maersk ships, and MPS-3 contains four AMSEA ships (Table III-5). This difference in ship mixes gives rise to three different container sizes. AMSEA ships will each be loaded with a total of 522 8'x8'x20' containers; Maersk ships with 340 8'6"x8'x20' containers each, and Waterman ships with a mix of 8'6"x8'x20', 6'x8'x20' and 8'x8'x20' containers for a total of 537 in each ship. For the purposes of this study, no distinction need be made

among these three sizes, since they are all categorized as large containers that require specialized equipment (i.e., LACHs, RTCHs, or large cranes) for handling.

TABLE III-5. MPS SHIP MIX [Ref. 8]

MPS Unit	AMSEA	Maersk	Waterman	Total
	Number of Ships by Type			
MPS-1	1		3	4
MPS-2		5		5
MPS-3	4			4

2. MPS Ammunition Containers

Each ship is to be loaded with a number of ammunition containers that vary according to shipbuilder. AMSEA ships hold 322 8'x8'x20' ammunition containers per ship, a Maersk ship holds 283 8'6"x8'x20' ammunition containers, and Waterman ships each hold 172 8'6"x8'x20' plus 150 6'x8'x20' ammunition containers. Thus, the total number of ammunition containers (irrespective of size) in each MPS unit is shown in Table III-6.

TABLE III-6. AMMUNITION CONTAINERS FOR MPS UNITS

MPS Unit	AMSEA	Maersk	Waterman	Total
	Number of Containers by Ship Type			
MPS-1	322	-	966	1,288
MPS-2	-	1,415	-	1,415
MPS-3	1,288	-	-	1,288

3. <u>MPS Equipment</u>

Typical items and quantities of support equipment designated as part of MPS-1 are shown in Table III-7. This equipment is intended to provide the capability to offload, handle, and transport all of the containers, including ammunition, coming ashore from MPS.

TABLE III-7. MPS EQUIPMENT ALLOCATION

Equipment	Quantity
Crane, RT, 30-ton	12
Truck, Forklift, RT, 4,000 lb	24
RTCH	10
LACH	4*
MILVAN chassis units**	48

*It is assumed that a like number of medium tractors will be provided as prime movers.

**These will serve as the interim container hauler until the November 1985-April 1986 period when they will be replaced by the LVS-MK48/MK14.

The capabilities and applicability of these MPS items of equipment for handling containerized ammunition are discussed in Chapters V and VII.

4. <u>MPS Offloading</u>

An MPS offloading period of 10 days is specified for a MAB in the current MMROP. However, in a November 1983 meeting [Ref. 8], a new requirement was introduced to complete offloading of a MPS unit and transfer the containers to a CSSA marshaling area in a 5-day period. Therefore, this study will use 5 days as the required offloading period for MPS.

E. SUMMATION

The preceding discussion has covered the task organizations, material assets, and buildup ashore of the various elements that make up the notional MAF and MAB considered in this study. Also presented was a description of current planning factors being used relative to the implementation of the MPS program.

Following is a brief rundown of the key points that influence the development of concepts for containerized ammunition support in an AOA, based on the information in this chapter and in the description of the baseline ammunition support system presented in Chapter II:

1. Force and Supply Buildup Ashore

- Combat Elements
  - -- From D-day until D+30, the preponderance of combat power ashore is the GCE; and (as quantified in Chapter IV), resupply of Class V(W) makes up the greater share of the ammunition support mission during this period.
  - -- As aviation units are phased ashore from D+5 through D+30, more and more of the total amounts of ammunition required is Class V(A); and (as quantified in Chapter IV), beyond D+30 the greater share of the ammunition resupply mission will be Class V(A).
- Combat Service Support Element
  - -- Marine CSS units begin coming ashore with the AE, build up as rapidly as possible, and, as resources become available, establish and expand supply dumps for various classes of supply.
  - -- CSSAs and ammunition storage areas/ASPs should be functioning by D+5. MAF ammunition storage areas/ASPs are operated by the ammunition company of the supply battalion, CSSE, which requires augmentation from other CSSE units for MHE and motor transport.
  - -- AE Class V supplies (15 DOS for a MAF or a MAB) will be in breakbulk form (i.e., wooden or metal pallets) and will be offloaded ashore by D+5.
  - -- AFOE Class V supplies (45 DOS for a MAF and 15 DOS for a MAB) will be a mix of breakbulk and large ISO containers, and will be offloaded ashore between D+5 and D+30 for a MAF and between D+5 and D+15 for a MAB (other than MPS).

2. Equipment Allocations

- Motor Transport
  - -- The HHMTT, which is found in almost all ammunition consuming units as well as in service support units of MAGTFs, is the primary transporter of breakbulk ammunition within an AOA.
  - -- The MK48/MK17, with an onboard crane, can be used to transport breakbulk ammunition or intermediate containers.
  - -- MK48/MK14 assets, which provide the sole transport capability for fully loaded large ISO containers, are concentrated primarily in the motor transport units of the CSSE of a MAF or MAB for force-wide support. (In a MAF, there are also 27 MK48s and 13 MK14s in the MWSG of the MAW; these might provide an added capability for transporting Class V(A) containerized cargo.)
- *Container Handling*
  - -- Both major items of container handling equipment, the LACH and the RTCH, are concentrated in the landing support unit of the CSSE of a MAF or MAB.
  - -- The LACH, which requires a medium tractor for operation and mobility, is used to offload ISO containers from landing craft.
  - -- The RTCH is the principal means of handling ISO containers in marshaling and storage areas.
- Container Unstuffing
  - -- The 4K RTFL provides the only mechanical means for unstuffing ISO containers.
  - -- Significant numbers of 4K RTFLs are found in the CSSE, ACE, and the artillery portion of the GCE. However, in this latter case, the primary role of the 4K RTFL is as an auxiliary prime mover for the M198 howitzer.

3. Maritime Pre-positioning Ships

- For purposes of this study, MPS employment will be considered primarily as a subordinate element of a MAF.
- The information provided concerning support equipment for a typical MPS is considered to be representative of MPS-1, MPS-2, and MPS-3.

Ammunition resupply impacts for the supported weapon systems cited above are presented in the next chapter, Ammunition Requirements; and the adequacy and capabilities of the equipment noted are discussed in Chapter V, Field Logistics System.

IV. AMMUNITION REQUIREMENTS

A. GENERAL

Ammunition requirements are developed in this chapter for two reasons: (1) to provide a basis for determining the overall level of ammunition transportation and handling required within an AOA and (2) to quantify the amounts of ammunition expended in various categories (e.g., artillery, mortars, bombs, rockets). Most of these categories are associated with specific using units and thus provide not only the quantities of ammunition but also an indication of the ultimate geographic distribution of the different ammunition types.

The procedures used in computing the ammunition requirements (expressed in short tons) are identical for the MAF and the MAB. Source data for these calculations were provided by Headquarters, Marine Corps, in the form of computer printouts from the MAGTF lift planning model. These computer printouts were provided as two separate data packages: one for ground ammunition, Class V(W), and the other for aviation ordnance, Class V(A). The Class V(W) data package provides daily intense and sustaining consumption rates for individual DODICs. The Class V(A) data package contains only the intense rate consumption for a MAF. Sustaining rate data for Class V(A) are estimated across the board as 80 percent of the intense rate requirement. Class V(A) requirements for a MAB are estimated as a percentage of the MAF requirements, based on numbers of aircraft by type.

Early in this effort, the study team determined ammunition requirements based on the average of intense and sustaining rates. After the first interim report, however, the SAC expressed concern that such an average might lead to an unrealistic estimate of actual ammunition requirements. The SAC thus suggested separate presentation of the requirements at the intense rate and at the sustaining rate.

The following sections of this chapter summarize the intense and sustaining rate requirements for both a MAF and a MAB. These requirements are expressed in short tons and in ISO container equivalent units (CEUs) for ground ammunition and aviation ordnance. Detailed short-ton calculations are contained in Appendix B, the CEU computations are shown in Appendix C, and the geographical distribution of ammunition requirements units in Appendix D.

B. MAF AMMUNITION REQUIREMENTS

1. Class V(W) Requirements (Short Tons)

Ammunition in Class V(W) was aggregated into eight major categories to illustrate how ammunition expenditures vary with the type of weapon system employed. The major categories of Class V(W) ammunition addressed in this report are:

- Small arms
- Mortars
- Tanks
- Artillery
- Demolitions
- Antitank
- Anti-air missiles
- Light-armored vehicles.

The source data provided by Headquarters, Marine Corps, provided the daily poundage (packaged weight) of each Department of Defense Identification Code (DODIC) required by a MAF engaged in combat. Each data item (i.e., DODIC) was placed into one of the above eight categories, and the short-ton totals for each category were computed. In the case of the artillery calculation, subtotals were also obtained for three subcategories: projectiles, propellants, and fuzes/primers. These subtotals are used later to estimate individual densities for each of these three subcategories. Table IV-1 shows the MAF Class V(W) daily requirement in short tons (STs) at the intense rate. As can be seen, the Class V(W) intense rate daily requirement varies widely among the different categories--from a high of 882 STs for artillery (approximately 78 percent of the total) to a low of 1 ST for the LAV(25) (an LAV mounting a 25-mm gun).

TABLE IV-1. CLASS V(W) INTENSE RATE MAF REQUIREMENTS

Category	Short Tons per Day
Artillery	882
Projectiles	(701)
Propellants	(158)
Fuzes/primers	(23)
Demolitions	105
Mortars	52
Small arms	38
Anti-air missiles	36
Tanks	16
Antitank	8
LAV(25)	1
Total	1,138

The Class V(W) sustaining rate calculations were performed in exactly the same manner as for the intense rate, but using the MAF Class V(W) sustaining data. As before, each DODIC was assigned to one of the eight ammunition categories, total pounds were obtained for each category, and pounds were converted to short-ton requirements. Table IV-2 shows the results of these procedures.

TABLE IV-2. CLASS V(W) SUSTAINING RATE MAF REQUIREMENTS

Category	Short Tons per Day
Artillery	355
Projectiles	(287)
Propellants	(58)
Fuzes/primers	(10)
Demolitions	85
Mortars	40
Small arms	17
Anti-air missiles	< 1
Tanks	5
Antitank	2
LAV(25)	≤ 1
Total	506 (approx.)

2. Class V(A) Requirements (Short Tons)

Ordnance in Class V(A) was aggregated into five major categories to illustrate how expenditures vary with the type of aircraft/weapon system employed. The major categories of Class V(A) ordnance addressed in this study are:

- Bombs
- Missiles
- Rockets
- Gun ammunition
- ECM devices.

Source data for these categories were in the form of 100-day intense rate requirements by DODIC or NALC. These values were converted to daily requirements and assigned to one of the five major categories shown above. Category totals were obtained and then converted to short tons as was done previously for Class V(W). Since the detailed Class V(A) source data are classified when individual NALCs are identified, they are not included in this report. This summary, including the information in Appendix B, however, is not classified. Table IV-3 shows the Class V(A) intense rate requirements by major category. Bombs and missiles clearly account for the majority of the requirements, specifically, about 88 percent of the total.

TABLE IV-3. CLASS V(A) INTENSE RATE MAF REQUIREMENTS

Category	Short Tons per Day
Bombs	714
Missiles	201
Rockets	56
Gun ammunition	39
ECM devices	31
Total	1,041

In estimating the Class V(A) sustaining rate requirements, a slightly different approach was used. The Class V(A) source data package did not contain individual NALC sustaining rate data but suggested that, for planning purposes, sustaining requirements could be estimated by applying an

across-the-board planning factor of 80 percent to the intense rate requirements. Thus, the requirements in Table IV-4 were obtained by multiplying the intense requirements of Table IV-3 by 80 percent.

TABLE IV-4. CLASS V(A) SUSTAINING RATE MAF REQUIREMENTS

Category	Short Tons per Day
Bombs	571
Missiles	161
Rockets	45
Gun ammunition	31
ECM devices	25
Total	833

C. MAB AMMUNITION REQUIREMENTS

1. Class V(W) Requirements (Short Tons)

MAB Class V(W) intense rate source data were aggregated into the eight major categories defined previously for the MAF. Computing the total pounds per category and converting to short tons yielded the values shown in Table IV-5.

TABLE IV-5. CLASS V(W) INTENSE RATE MAB REQUIREMENTS

Category	Short Tons per Day
Artillery	278
Projectiles	(218)
Propellants	(53)
Fuzes/primers	(7)
Demolitions	27
Anti-air missiles	18
Mortars	17
Small arms	10
Tanks	4
Antitank	2
LAV(25)	< 1
Total	357 (approx.)

The high and low requirements, respectively, are artillery and the LAV(25), just as in the MAF case. The short-ton values for the artillery subcategories (i.e., projectiles, propellants, fuzes/primers, respectively) are shown since they are used later in the determination of the artillery CEUs.

The MAB Class V(W) sustaining rate calculations were performed in the same manner as for the intense rate. Using the sustaining rate data for these calculations yields the results shown in Table IV-6.

TABLE IV-6. CLASS V(W) SUSTAINING RATE MAB REQUIREMENTS

Category	Short Tons per Day
Artillery	112
Projectiles	(89)
Propellants	(20)
Fuzes/primers	(3)
Demolitions	22
Mortars	13
Small arms	5
Tanks	1
Antitank	.1
Anti-air missiles	< 1
LAV(25)	< 1
Total	156 (approx.)

2. Class V(A) Requirements (Short Tons)

The Class V(A) data package provided by Headquarters Marine Corps contained data for aircraft in support of MAF-sized operations only. Thus Class V(A) requirements for the MAB could not be determined directly from source data as in the case of Class V(A) MAF requirements. However, assuming requirements are proportional to the number of aircraft being supported, the MAB requirements can be estimated similarly as a percentage of the MAF requirements based on the ratio of MAG aircraft to MAF aircraft. Hence, for a given ordnance category "i" the MAB requirement can be expressed as:

$$\text{MAB Rqmt}_i = \sum_{\text{all } j} \text{MAB Rqmt}_{ij} = \sum_{\text{all } j} \text{MAF Rqmt}_{ij} \times \frac{\text{No. of type } j \text{ acft in a MAB}}{\text{No. of type } j \text{ acft in a MAF}} \qquad \text{(Eq. IV-1)}$$

where: i represents an ordnance category (e.g., bombs, rockets)
j represents an aircraft type (e.g., AV-8, CH-53).

The last term in the above equation is referred to as the notional MAB/MAF aircraft ratio. These ratios are computed based on the aircraft quantities in Marine Air-Ground Task Forces [Ref. 9], and are shown in Table IV-7.

TABLE IV-7. MAB/MAF AIRCRAFT RATIOS

Aircraft	MAB/MAF Ratio
AV-8	0.40
F-4/FA-18	0.33
A-6	0.50
EA-6	0.47
OV-10	0.50
CH-53	0.38
CH-46	0.31
UH-1	0.25
AH-1	0.33

Using the MAB/MAF ratios of Table IV-7, Equation IV-1, and the MAF requirements presented in Table I-3, the Class V(A) intense rate MAB requirements were then computed. These results are shown in Table IV-8.

TABLE IV-8. CLASS V(A) INTENSE RATE MAB REQUIREMENTS

Category	Short Tons per Day
Bombs	298
Rockets	21
Missiles	78
Gun ammunition	14
ECM devices	12
Total	423

As in the MAF case, the largest Class V(A) requirement is for bombs and the smallest is for ECM devices. To arrive at the Class V(A) sustaining rate requirements shown in Table IV-9, the intense rate values of Table IV-8 were multiplied by the planning factor of 80 percent.

TABLE IV-9. CLASS V(A) SUSTAINING RATE MAF REQUIREMENTS

Category	Short Tons per Day
Bombs	238
Rockets	62
Missiles	17
Gun ammunition	11
ECM devices	10
Total	338

D. CONTAINER EQUIVALENT UNITS

1. Computation Procedures

In order to quickly ascertain the ammunition requirement for each major category in container-size units, tonnages were converted to CEUs using one of the two procedures discussed below. The choice of which procedure to use was based on a comparison of the density of the category being converted to the critical density of an 8'x8'x20' ISO container. Critical density for this size container is equal to 37.1 lb/ft^3 [Ref. 10] and represents the density that would simultaneously permit the container to be loaded to its maximum weight and cube capacities. Hence, the critical density serves as a measure of whether a container loaded with a given ammunition category will "weigh out" or "cube out" first. Ammunition categories with a density greater than or equal to the critical density of 37.1 lb/ft^3 will weigh out first while those with a density less than the critical density will cube out first. The two procedures used for converting short tons to CEUs are:

Procedure 1 - Category Density $\geq$ Critical Density (37.1 lb/ft^3)

$$CEU_i = \frac{ST_i}{19} \qquad \text{(Eq. IV-2)}$$

where: CEU_i = the number of CEUs of ammunition in category "i"

ST_i = the number of short tons of ammunition in category "i"

19 = assumed to be the average number of STs of palletized ammunition per 8'x8'x20' container.

Procedure 2 - Category Density < Critical Density (37.1 lb/ft^3)

$$CEU_i = \frac{ST_i}{D_i} \times 2000 \times \frac{1}{1110 \times 0.6} \qquad \text{(Eq. IV-3)}$$

where: CEU_i = the number of CEUs of ammunition in category "i"

ST_i = the number of short tons of ammunition in category "i"

D_i = the density of ammunition in category "i"

2000 = a conversion factor with the units (lbs/ST)

1100 = the cubic feet of cargo capacity in a 8'x8'x20' container [Ref. 10]

0.6 = a broken stowage factor for ammunition [Ref. 10].

This simplifies to:

$$CEU_i = \frac{ST_i}{D_i} \times 3$$

In order to choose between these two procedures the category density (D_i) must be known so that it can be compared to the critical density. The following paragraphs address the estimation of these category densities.

2. Estimating Category Densities (D_i)

Category densities are expressed in pounds per cubic foot and were computed by dividing the total packaged weight of a given ammunition category by the total cube for that same category. These weight and cube data were taken from References 5 and 6. The notation D_i was used to denote the

density of ammunition in category "i." Actual calculations of the category densities are shown in Appendix C and summarized in Table IV-10.

Since the artillery category is made up of projectiles, propellants, and fuzes/primers that each have substantially different densities, the three subcategory densities shown below were used rather than an average density for the entire category. This approach leads to a more accurate estimation of the artillery CEUs, as shown in the following paragraphs.

TABLE IV-10. AMMUNITION DENSITIES

Category	Density (lb/ft^3)
Class V(W)	
Small arms	71.4
Mortars	36.0
Tanks	37.9
Artillery	
Projectiles	99.6
Propellants	22.3
Fuzes/primers	42.4
Demolitions	44.0
Antitank	15.1
Anti-air missiles	21.5
Light-armored vehicles	29.4
Class V(A)	
Bombs	34.5
Rockets	30.0
Missiles	17.7
Gun ammunition	58.5
ECM devices	25.1

3. MAF CEUs

The basic procedure for computing the CEUs needed for the various ammunition categories is shown in Figure IV-1.

To compute the MAF (intense rate) CEUs, the data from Table B-4 were used. Detailed calculations are shown in Appendix C, and the results are summarized below in Table IV-11.

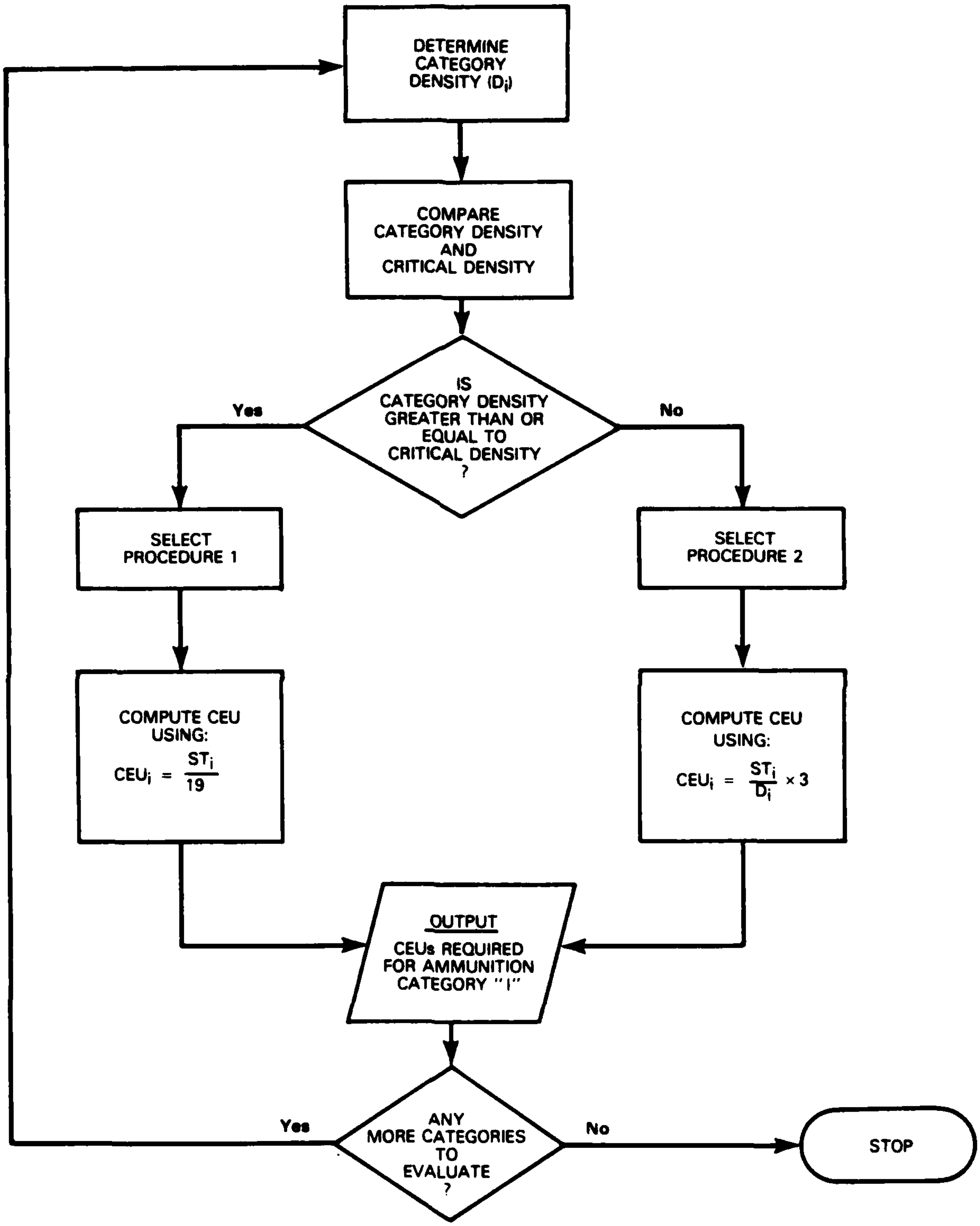


FIGURE IV-1.
CEU COMPUTATION PROCEDURE

TABLE IV-11. MAF INTENSE RATE CEUs*

Category	CEUs per Day
Artillery	59.4
Demolitions	5.5
Mortars	4.3
Small arms	2.0
Anti-air missiles	4.9
Antitank	1.6
Tanks	0.8
LAV(25)	0.1
Class V(W) subtotal	78.6
Bombs	61.2
Missiles	33.5
Rockets	5.6
ECM devices	3.7
Gun ammunition	2.1
Class V(A) subtotal	106.1
Total Class V(W) and Class V(A)	184.7

*CEU values have been selectively checked and found to be in reasonable agreement with results obtained using 6th MAB's methodology for computing MPS container requirements, as determined in a 12 April 1984 telephone conversation with a representative of 6th MAB.

By far, artillery for ground munitions and bombs for air munitions account for the greatest daily number of CEUs. Together they comprise approximately 65 percent of the total requirement. Other munition categories are on the order of five CEUs per day or less, except for aircraft missiles, which are the third most prominent item of daily usage.

CEU calculations for a MAF at the sustaining rate are also shown in Appendix C. These calculations were performed in the same manner as in the case of the intense rate calculations, but use the results from Table B-6 rather than the intense values from Table B-4. Table IV-12 summarizes the CEU requirements at the sustaining rate. The results are seen to be proportionately about the same as in the case of the intense rates; and, for Class V(W), most categories are less than one CEU per day.

TABLE IV-12. MAF SUSTAINING RATE CEUs

Category	CEUs per Day	
Artillery	23.4	
Demolitions	4.5	
Mortars	3.3	
Small arms	0.9	
Anti-air missiles	< 0.1	
Antitank	0.4	
Tanks	0.3	
LAV(25)	< 0.1	
Class V(W) subtotal	33.0	(approx.)
Bombs	48.9	
Missiles	26.8	
Rockets	4.5	
ECM devices	3.0	
Gun ammunition	1.6	
Class V(A) subtotal	84.8	(approx.)
Total Class V(W) and Class V(A)	117.8	

4. Phasing of MAF CEU Requirements

Phasing of Class V(W) CEU requirements was not a consideration since all units requiring extensive Class V(W) support are ashore by D+1 and requiring ammunition supply support from that point on. For Class V(A), however, the airbases ashore generally will not be established all at once; thus, the geographical distribution and operational times of the five major air facilities described in Chapter III had to be considered. The Class V(A) intense rate CEU requirement of Table IV-11 were distributed among these facilities as shown in Table IV-13, based on the requirements defined in Reference 6 (see Appendix D).

TABLE IV-13. GEOGRAPHICAL DISTRIBUTION OF MAF CLASS V(A) INTENSE RATE CEUs

Facility	CEUs per Day
Forward Base 1	16.8
Forward Base 2	16.8
Main Base 1	13.4
Main Base 2	13.4
SELF	45.7
Total	106.1

As before, the sustaining rate CEU distribution was estimated to be 80 percent of the intense rate values. These results are summarized in Table IV-14.

TABLE IV-14. GEOGRAPHICAL DISTRIBUTION OF MAF SUSTAINING RATE CEUs

Facility	CEUs per Day
Forward Base 1	13.4
Forward Base 2	13.4
Main Base 1	10.7
Main Base 2	10.7
SELF	36.6
Total	84.8

To take into account the time phasing ashore of aviation units, the daily rate of Tables IV-13 and IV-14 apply only from the time at which a particular base becomes operational. The operational times in Table IV-15 are those presented in Chapter III for the phasing ashore of the various MAGs in the ACE.

TABLE IV-15. AIR BASE OPERATIONAL TIMES

Facility	Assumed Operational Time
Forward Base 1	D+5
Forward Base 2	D+8
Main Base 1	D+12
Main Base 2	D+15
SELF	D+30

Putting the operational times and the CEUs for the individual bases together results in the time-phased CEU requirements shown in Table IV-16.

TABLE IV-16. CLASS V(A) CEU REQUIREMENTS VERSUS TIME

Operational Time	Intense Rate CEUs	Sustaining Rate CEUs
D+5	16.8	13.4
D+8	33.6	26.8
D+12	47.0	37.5
D+15	60.4	48.2
D+30	106.1	84.8

5. MAB CEUs

The procedures for calculating MAB CEUs are identical to those for the MAF, as shown previously in Figure IV-1. Data for the intense rates are found in Table B-9, and the detailed calculations are shown in Appendix C. Table IV-17 summarizes these results. Once again, artillery, bombs, and missiles account for the largest share of the total requirement, by far.

TABLE IV-17. MAB INTENSE RATE CEUs

Category	CEUs per Day	
Artillery	19.0	
Demolitions	1.4	
Mortars	1.4	
Small arms	0.5	
Anti-air missiles	2.5	
Antitank	0.4	
Tanks	< 0.2	
LAV(25)	0.1	
Class V(W) subtotal	25.5	(approx.)
Bombs	25.5	
Missiles	13.0	
Rockets	2.1	
ECM devices	1.4	
Gun ammunition	0.7	
Class V(A) subtotal	42.7	
Total Class V(W) and Class V(A)	68.2	(approx.)

Table IV-18 shows the results of the sustaining rate MAB CEU calculations, with the same proportionate result.

TABLE IV-18. MAB SUSTAINING RATE CEUs

Category	CEUs per Day	
Artillery	7.6	
Demolitions	1.2	
Mortars	1.1	
Small arms	0.3	
Anti-air missiles	< 0.1	
Antitank	0.2	
Tanks	0.1	
LAV(25)	< 0.1	
Class V(W) subtotal	10.7	(approx.)
Bombs	20.4	
Missiles	10.3	
Rockets	1.7	
ECM devices	1.2	
Gun ammunition	0.6	
Class V(A) subtotal	34.2	
Total Class V(W) and Class V(A)	44.9	(approx.)

At the sustaining rate, artillery, bombs, and missiles comprise slightly more than 85 percent of the total CEU requirement.

6. Phasing of MAB CEU Requirements

As for the MAF, the phasing of MAB CEU requirements is more of an issue for Class V(A) than for Class V(W). Class V(W) support is required almost immediately because the majority of the ground combat force is ashore by D+1; however, the Class V(A) support required depends on when the airbases become operational.

For study purposes, it was assumed that initial air operations, within the AOA, would take place about D+5 from a forward air base, and that a main base would be operational by D+12. By assuming that the forward base/main base distribution for the MAB was in the same proportion as it was for the MAF, the geographical distribution would be as shown in Table IV-19.

TABLE IV-19. GEOGRAPHICAL DISTRIBUTION OF MAB INTENSE RATE CEUs

Facility	CEUs per Day: Bombs	Missiles	Rockets	ECM Devices	Gun Ammo	Total
Forward Base	12.2	9.5	1.0	0.9	0.4	24.0
Main Base	13.3	3.5	1.1	0.5	0.3	18.7
Total	25.5	13.0	2.1	1.4	0.7	42.7

The sustaining rates shown in Table IV-20 result from applying a standard planning factor of 80 percent to the intense rates of Table IV-19.

TABLE IV-20. GEOGRAPHICAL DISTRIBUTION OF MAB SUSTAINING RATE CEUs

Facility	CEUs per Day: Bombs	Missiles	Rockets	ECM Devices	Gun Ammo	Total
Forward Base	9.8	7.6	0.8	0.7	0.3	19.2
Main Base	10.6	2.8	0.9	0.4	0.2	14.9
Total*	20.4	10.4	1.7	1.1	0.5	34.1

*Totals vary slightly with Table IV-18 due to rounding.

Putting the operational times and the CEUs for the two bases together results in the time-phase CEU requirements shown in Table IV-21.

TABLE IV-21. CLASS V(A) MAB CEU REQUIREMENTS VERSUS TIME

Operational Time	Intense Rate CEUs	Sustaining Rate CEUs
D+5	24.0	19.2
D+12	42.7	34.1

E. CORRELATION WITH FLS CONTAINERIZATION ESTIMATES

Before summing up the key observations regarding the foregoing computations, a comment is in order concerning a comparison of the total number of MAF AFOE ammunition containers determined herein and that presented in the lates FLS equipment validation summary [Ref. 11].

From the numbers of daily CEUs for MAF operations presented in Tables IV-11 and IV-12, the 45-day CEU requirements are seen to be:

	Intense	Sustaining
Class V(W)	3,537	1,485
Class V(A)	4,775	3,816
Total	8,312	5,301

In Reference 11, the total number of Class V containers (comparable to CEUs) is indicated as:

Class V(W)	1,456
Class V(A)	4,047
Total	5,503

There is very close correlation between the sustaining rate CEU total number and the total Class V container number from Reference 11. However, there is a significant difference noted when comparing the intense rate CEU quantity with the total Class V container number from Reference 11--the principal difference arising from the much greater number of CEUs for Class V(W) at the intense rate.

It is beyond the scope of this study to resolve this disparity, if, in fact, this is a disparity. Based on the guidance of the SAC to consider the "real world" situation as far as anticipated level of wholesale ammunition containerization for the AFOE during the midrange, the difference noted should not present a problem in the concepts described in Chapter VII. Thus, the summation that follows focuses primarily on the retail aspects of ammunition resupply and the possible impact of different ammunition consumption rates on containerization.

F. SUMMATION

This chapter has quantified daily ammunition consumption for various categories of Class V(W) and Class V(A) in terms of both short tons and CEUs. Determination of the daily short tonnages indicates very quickly which categories are the highest users and, thus, would place the greatest demands on the logistical system for resupply. Determination of the CEUs establishes a common unit of measure (i.e., an 8'x8'x20' ISO container, or equivalent) for the various categories to facilitate later analysis of the requirements for container handling, hauling, storage, etc., for various options.

Following is a brief recap of the insights derived from the foregoing computations.

1. MAF Operations

- Class V(W)
  - -- Artillery, by far, is the biggest user at both the intense and sustaining rates--59.4 CEUs (76 percent of the total) and 23.4 CEUs (71 percent of the total), respectively. This establishes artillery as the Class V(W) category that places the greatest demands on the ammunition resupply system, as well as the Class V(W) category that could receive the greatest benefits from containerization concepts that provide for efficient movement of large quantities of ammunition forward. (A complicating factor is the widespread dispersion of artillery firing batteries and their normal policy of rapid, intermittent relocation.)
  - -- The remaining categories of Class V(W) are significantly less, ranging from a maximum of 5.5 CEUs per day for the highest category to much less than one CEU per day. Thus, for these categories it would appear that rapid breakout of incoming containerized ammunition from a wholesale format (i.e., large ISO containers) to a retail format (i.e., palletized unit loads or equivalent) for issue to using units would be the best course of action.
- Class V(A)
  - -- Once all MAF units are ashore, the Class V(A) requirements are the larger share of the total ammunition expenditures in the AOA--106.1 CEUs out of 184.7 (57 percent of the total) at the intense rate and 84.8 out of 117.8 CEUs (72 percent of the total) at the sustaining rate.

-- Within Class V(A), bombs and missiles make up the predominant share of the total requirements--94.7 CEUs (89 percent of the total) at the intense rate and 75.7 CEUs (once again 89 percent of the total) at the sustaining rate.

-- The foregoing suggests that it would be extremely desirable to transport containerized Class V(A) stocks coming into the AOA directly to the vicinity of operating airfields as rapidly as possible.

2. MAB Operations

- The above comments for the MAF apply also to the MAB, but on a reduced scale as far as quantities are concerned. Of interest, however, is the fact that once all forces are ashore, the Class V(A) requirements are an even greater share (than in the case of the MAF) of the total ammunition expenditures--42.7 out of 68.2 CEUs (63 percent of the total) at the intense rate and 34.2 out of 44.9 CEUs (76 percent of the total) at the sustaining rate.

V. FIELD LOGISTICS SYSTEM

A. GENERAL

Based on the study guidance to look at "effective and efficient use" of current and projected Marine Corps equipment, this chapter addresses the capabilities and applicability of specific components of three of the major subsystems of the FLS--containers, materials handling, and motor transport. Chapter III presented a general description of use, quantities, and unit allocations of the MHE and motor transport that are found in MAGTFs (and are part of the FLS).

Below is a list of the components in each of the subsystems to be considered regarding their actual or potential role relative to the unitization, handling, and unstuffing of containerized ammunition:

- Containers
  - -- Container, 8'x8'x20' (commercial)
  - -- Pallet container (PALCON), 41"x40"x48"
  - -- Quadruple container (QUADCON), 6'10"x4'9.5"x8'
  - -- Shipping frame, 8'x8'x10'
  - -- Shipping frame, 4'x8'x6'8" (SIXCON)
- Materials handling equipment
  - -- RTFL, 4K
  - -- RTFL, 6K
  - -- Tractor, rubber-tired, articulated steer, 10K
  - -- LACH, 22.5 ton
  - -- RTCH, 50,000 lb
  - -- Rough-terrain crane, 30 ton
- Motor transport
  - -- HMMWV, 5/4 ton
  - -- HHMTT, 5 ton
  - -- MK48, LVS front power unit (FPU)
  - -- MK14, Container Hauler
  - -- MK17, Dropside Cargo with crane

The following discussion covers each of the above FLS components in turn. Also included is a brief assessment of the possible use of the medium girder bridge (MGB) transport equipment for containerizing ammunition pallets. A great deal of graphic material exists on this subject (notably the FLS Status Report, [Ref. 12] and similar documents). Only enough background descriptive information is presented here to ensure the completeness and clarity of this study. Unless otherwise noted, the source of physical and operational data is Reference 12.

B. CONTAINER SUBSYSTEM

1. Container, 8'x8'x20'

The commercial ISO container, 8'x8'x20' (Figure V-1), is an enclosed, reusable, weatherproof container for transporting or storing unit loads, packages, or bulk items of all classes of supply. This intermodal container is compatible with containerships of the merchant fleet. The empty weight of the container is about 4,200 pounds and its cargo carrying capacity is about 20 tons. Access to container contents is through double-doors in one end, which has a door opening 7' high and 7'6" wide.

For the case at hand, DoD guidance is that ammunition will be containerized at the source (e.g., CONUS depots or ammunition plants) to the extent practicable [Ref. 13]. A favorable feature of the nature of the conventional ammunition palletized unit loads that will be used to stuff containers is that, in almost all cases, single (or very few) DODIC items can be placed in individual containers.

Safe transport of containerized ammunition by all modes of transportation (commercial rail, truck, ship, etc., as well as by military means) requires provision of approved load restraint systems, i.e., blocking and bracing, to ensure that the palletized unit loads remain intact and stationary throughout the transportation network. Such restraint systems in commercial containers have been tested by the Defense Ammunition Container System (DACS) and have been approved by the United States Coast Guard and the American Association of Railroads (AAR).

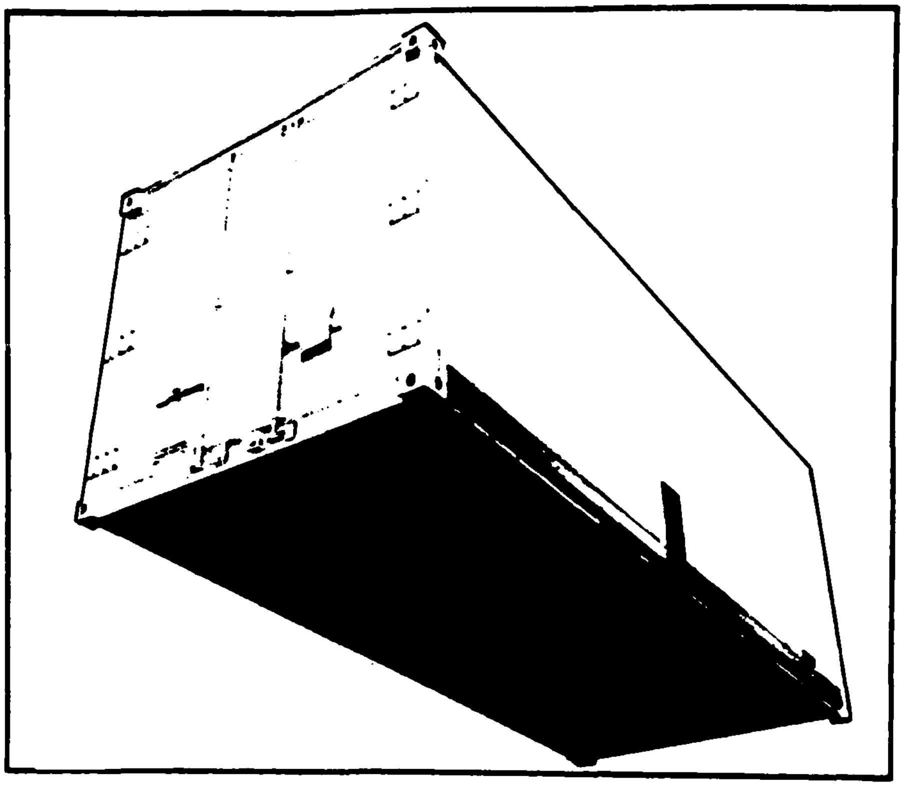


FIGURE V-1.
COMMERCIAL CONTAINER, 8'×8'×20'

The ISO container provides a convenient means for unitizing and transporting large quantities of ammunition into an AOA. Likewise, the ISO container affords an excellent means for temporary storage, thus enhancing capabilities for environmental protection and security for either all or selected munitions items.

However, two aspects of the routine use of the ISO 8'x8'x20' enclosed container for all ammunition unitization are worthy of comment:

- Weight/cube efficiency. As indicated in Chapter IV and in Appendix C, the density of most DODICs is such that in many cases the cargo weight capability of the container is reached before the available volume is utilized. Thus, more efficiency might be achieved, particularly in the logistical pipeline, through the use of specialized (i.e., reduced height) containers.
- Accessibility to contents. The current method for unstuffing the ISO container is through the use of the 4K RTFL, which enters through the end opening and extracts each ammunition pallet one

> so that the forklift can readily get inside. This procedure is time-consuming and creates a need for container handling equipment to move and position full containers at the terminus where they are to be unstuffed.

The above problems were presented as follows in the DoD Program Management Plan for Containerized Ammunition Distribution Systems Development [Ref. 13], which indicated:

> A requirement for commercial dropside, open top, half size munition containers which could be more conducive to efficient transportation than van-type containers. The high density of munition cargo does not lend itself well to cube utilization of van containers and use of half size containers would improve utilization, reduce transportation costs, and reduce container handling equipment requirements. Potential benefits of using open top containers will have to be weighed against potential safety and security problems.

As a consequence, the Air Force has initiated two projects to assess the feasibility of using ISO flat rack containers to move air munitions. These projects, Easy ISO and Commando Rack are discussed in Chapter VI.

2. PALCON, 41"x40"x48"

The PALCON (Figure V-2) is a weatherproof, reusable container for use at all force levels to support the storage and movement of organizational property and organic consumable supplies. The PALCON's empty weight is 250 pounds and its cargo capacity is 1,000 pounds. It has a double-opening door on one side with an opening of 33"x34" and can hold a rack and six bin inserts (10"x17"x45") for small items, if desired. Eight PALCON units can be linked together in a 2x2x2 configuration; 24 PALCONs can be accommodated by an 8'x20' logistics trailer.

In development of the FLS, PALCONs were not envisioned for use as ammunition containers. This is especially true for intertheater movement. The current palletized unit loads (wooden pallets) are about the size of PALCONs (exterior volume = 45.6 cu ft; interior volume = 31.5 cu ft) or less, but can accommodate significantly greater total loads. For example,

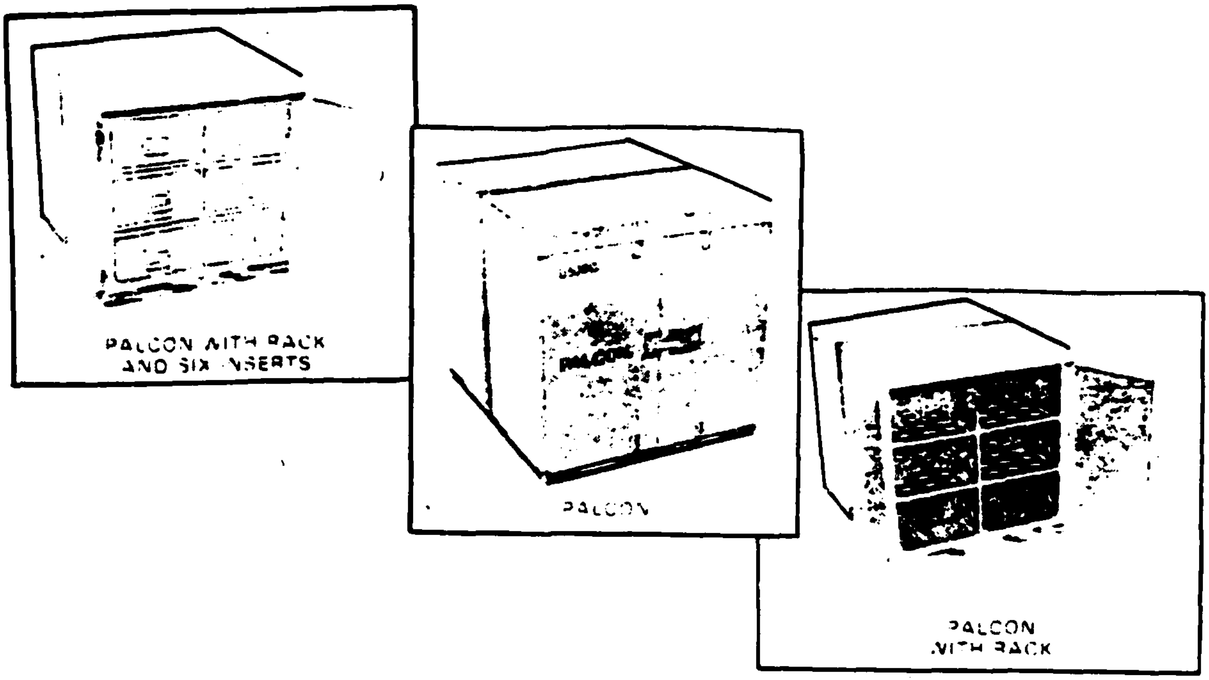


**FIGURE V-2.
PALCON**

a small arms pallet with a volume of 37.5 cu ft has a gross weight of about 2,700 pounds. These pallets are, to the extent possible, consistent with stowage space on Navy amphibious assault shipping for Marine Corps Class V(W) and are suitable for the movement of ammunition ashore during the landing of the AE. Further, for later phases of the amphibious operation, palletized unit loads can be stuffed into 8'x8'x20' containers by DODIC at CONUS ammunition plants or depots (or at ports), with no unstuffing until the containers are opened in the AOA.

Within an AOA, breaking down palletized unit loads into individual ammunition boxes for packing into PALCONs (which have a payload capacity smaller than that of the pallets) would not appear to offer any added effectiveness or efficiency in the ammunition resupply process. If PALCONs were to be used routinely for movement of ammunition forward from ASPs to using units, the daily workload of stuffing the PALCONs (which would include blocking and bracing to ensure load stability) and handling would be enormous.

PALCONs do offer the advantages of environmental protection and security when compared to wooden pallets. Thus, although large scale use of

PALCONs, as currently configured, for ammunition movement on a routine basis would not be prudent for the reasons noted above, the use of PALCONs selectively for specialized missions (e.g., a case where the only available cargo carriers are 5/4-ton HMMWVs) might provide a convenient means for efficient unitization and transport of ammunition packages. Also, under all circumstances, PALCONs offer the potential of providing secure, dry stationary storage for relatively small quantities of ammunition.

Based on the study guidance, the above discussion is predicated on current equipment/capabilities or those projected for implementation during the midrange period. The one aspect that could make PALCONs more attractive for recurrent use as an ammunition container within an AOA would be the provision of a variety of honeycomb inserts for different types of ammunition that would permit optimum packing density of "bare rounds" or rounds in sealed fiber canisters within the PALCON. Under this concept, incoming palletized unit loads could be depalletized and depackaged in the ASP and the bare rounds or canisters placed in the inserts within PALCONs for trans-shipment to using units. On the premise that the inserts would be made of polyethylene or some other lightweight material, the packing efficiency of the PALCON would be significantly greater than in the case of loading it with ammunition boxes. (For example, in the case of the current 51-pound box of three 81-mm HE mortar rounds, almost 45 percent of the total weight is the box and packing materials.) In addition to efficient use of the PALCON, this procedure could deliver ammunition to using units in a much more "user friendly" configuration, but it would add a workload requirement for the FSSG ammunition company for which it is not currently staffed.

3. QUADCON, 6'10"x4'9.5"x8'

The QUADCON (Figure V-3) is a weatherproof, reusable container of intermediate size to support the storage and movement of organizational property and organic consumable supplies. It is compatible with the cargo handling and stowage configurations of U.S. Navy amphibious ships and the merchant fleet. The QUADCON's empty weight is 2,565 pounds and its cargo capacity is 7,435 pounds. It has double doors on each 4'9.5" side with

weatherproof sealing strips and latches; the door openings are 5'5" high by 4'2" wide. The QUADCON has a connecting capability of two, three, or four unit arrays; and the four unit array can be accommodated by an 8'x20' logistics trailer. The QUADCON can be handled by a forklift from all four sides and by a sling from a crane or helicopter.

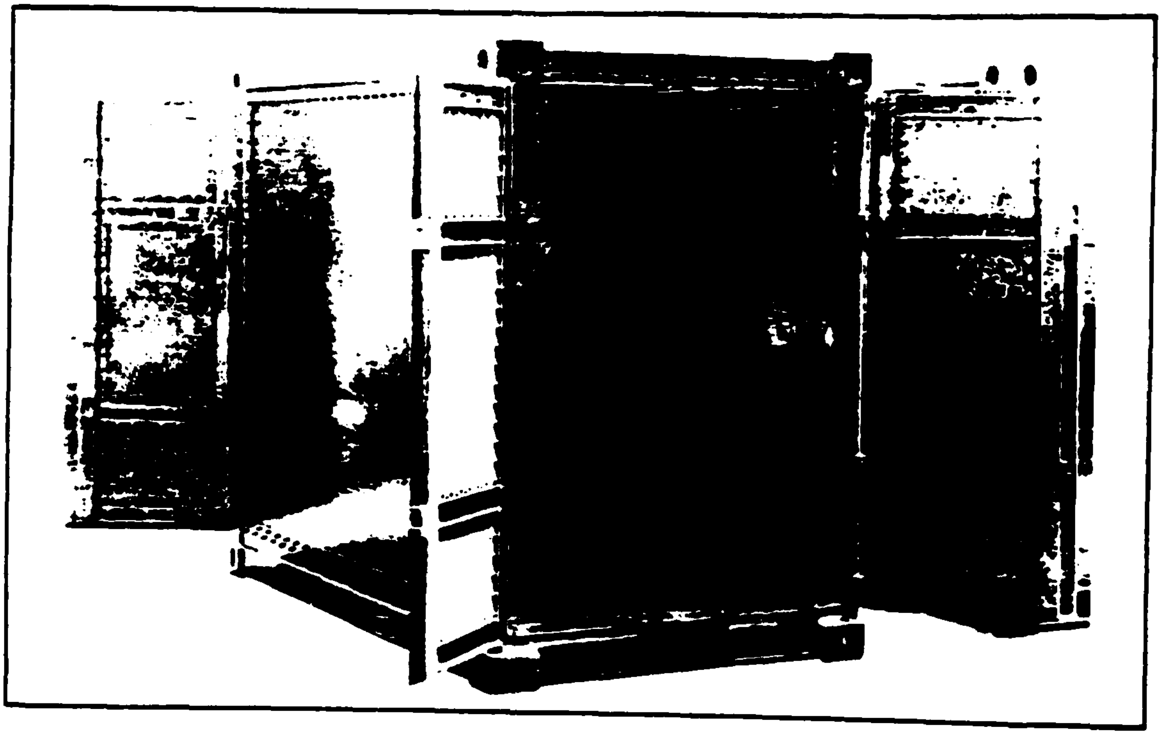


FIGURE V-3.
QUADCON

As in the case of the PALCON, the QUADCON was not envisioned in the FLS program for use as an intertheater ammunition container. Based on the increased tare weight of the combination, the payload capacity of a four unit QUADCON array would be at least 5 tons less than that of one ISO 8'x8'x20' container. Also, as with the PALCON, the enclosed nature of the QUADCON provides environmental protection and security not present with wooden pallets.

Within an AOA, the QUADCON could offer the potential of being useful for onward movement of large quantities of ammunition beyond ammunition supply points to using units, particularly when the transport mode is by helicopter. Based on its larger size (compared to the PALCON) and payload capacity, both individual palletized unit loads and ammunition boxes could be secured by blocking and bracing within the QUADCON. However, no data exist concerning the stuffing of QUADCONs with ammunition pallets; thus the ability to optimally pack a QUADCON may be questionable. The ability to gain access from two sides of the QUADCON is a definite asset in both stuffing and unstuffing. Most important, this, by necessity, would be a manual operation requiring a significant commitment of manpower resources. This suggests that such use of the QUADCON should probably be on an exceptional or emergency basis.

Due to the inherent inefficiency of ammunition packaging, the configuration of the palletized unit loads, and the questionability as how efficiently the QUADCON can be stuffed, the potential that QUADCONs may promise for the unitization of ammunition loads cannot be realized unless special provisions are made. As suggested above for the PALCON, the corrective action could be the provision of internal racks with honeycomb inserts for various types of "bare round" ammunition. However, in this case, as with the PALCON, the breakdown of the incoming palletized unit loads in the ASP to a "bare round" configuration for placing into the QUADCON inserts would be an extremely heavy (and currently unprogrammed) workload for the ammunition company. A better approach would be to ensure that incoming ammunition is packaged in a manner that would facilitate placing into a QUADCON with little or no extraordinary effort required on the part of ASP personnel. To accomplish this, however, would require the cooperation of the Army, the single manager for ammunition packaging.

4. Shipping Frame, 8'x8'x10'

The 8'x8'x10' FLS shipping frame, Figure V-4, is a reusable, open top cargo carrier of steel construction to support the mounting and movement of water purification equipment, as well as the unitization and movement of

designated bulk material. Its empty weight is 3,000 pounds and its cargo capacity is 7,000 pounds (less than that of the QUADCON). The shipping frame construction enables handling by a forklift from all four sides, and a two unit array can be connected to fit the 20-foot cell of a containership. Current plans are to procure this item for provision as government furnished equipment (GFE) for mounting units such as the 600 gallons per hour reverse osmosis water purification unit (ROWPU), which is part of the service support subsystem of FLS; at this time there are no plans by the Marine Corps to procure the 8'x8'x10' frame as a separate end item.

The payload capacity of two 8'x8'x10' frames is at least 30 percent less than that of one ISO 8'x8'x20' container. Thus, the shipping frame would not appear to be an efficient intertheater carrier of ammunition.

Within an AOA, the 8x8'x10' frame could conceivably be used as a carrier for palletized ammunition loads. However, the orientation of the end and side frame and bracing would seem to preclude accessibility from the sides or ends for a forklift to place pallets on the base of the frame. It is understood, however, that the side braces are (or could be made) removable, thus alleviating this problem.

The number of these frames to be procured is significantly smaller than that of PALCONs and QUADCONs (i.e., by an order of magnitude--100s vs 1,000s), and the unit cost of the 8'x8'x10' frame $5,834 for the current buy, is about $1,000 greater than that of the QUADCON. The unit cost of fabricating the honeycomb inserts (if that were done) for the QUADCON mentioned above would not be significantly greater. Thus, if the choice for an ammunition container were only between this shipping frame and the QUADCON configured to hold bare rounds, the selection would be obvious--the modified QUADCON. If the choice were between the shipping frame and the existing QUADCON, the selection would be more more difficult; but would probably still be the QUADCON based on less cost and better environmental protection and security.

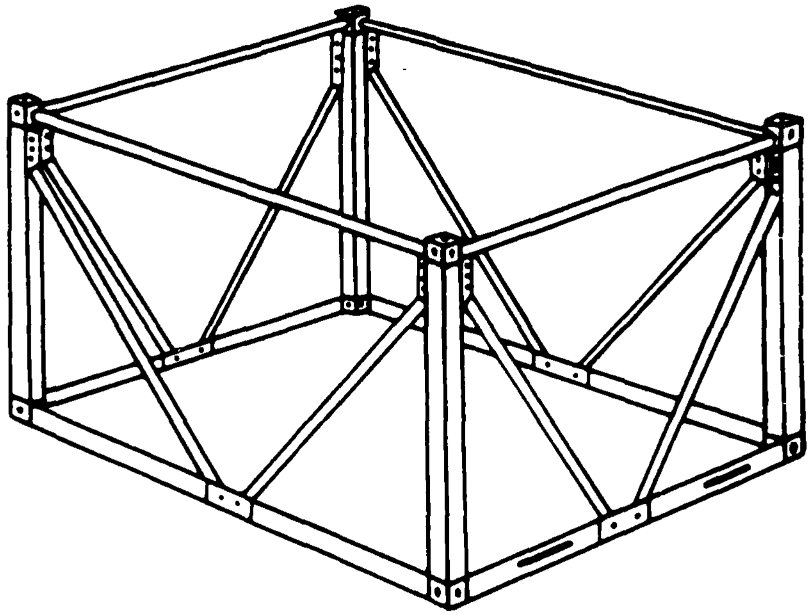


FIGURE V-4.
SHIPPING FRAME, 8'×8'×10'

5. Shipping Frame, 4'x6'8"x8'

The 4'x6'8"x8' shipping frame (SIXCON), Figure V-5, is a reusable, open top cargo carrier of steel construction to support the mounting and movement of various items of organizational equipment as well as the unitization and mounting of designated bulk material. Its empty weight is 1,560 pounds (not including a 400-pound floor) and its cargo capacity is 8,040 pounds (not including a 400-pound floor). This frame can be handled by a forklift from all four sides, and a six unit array can be connected to form an 8'x8'x20' configuration that will fit in the 20-foot cell of a containership. Current plans are to procure this item for provision as GFE for mounting FLS Service Support equipment such as the fuel/water pump and storage modules; at this time there are no plans by the Marine Corps to procure the SIXCON as a separate end item.

Although the payload capacity of these frames individually is quite good, the limitations on gross weight of a six unit array during intermodal transport would generally limit its utility as an efficient intertheater carrier of ammunition.

Within an AOA, the SIXCON could be used as a carrier for palletized ammunition loads as was the case for the HALFCON. The SIXCON could provide a superior means of combining ammunition pallets for helicopter lift.

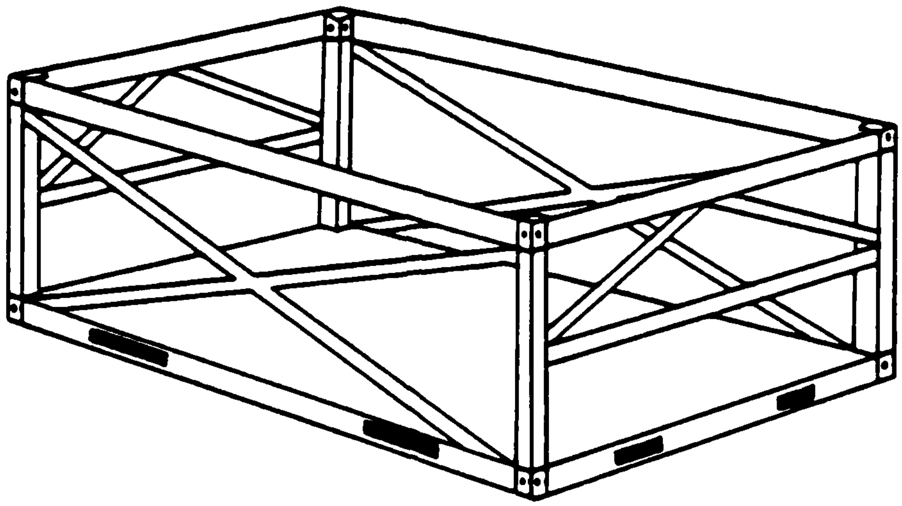


FIGURE V-5.
SHIPPING FRAME, 4'×6'8"×8'

However, neither the end nor side rails/braces are removable, thus pre venting loading of the frame with a forklift. Thus, if it should be decided to use SIXCONs as ammunition carriers, a design change should be incorporated to permit removal of the side rails and braces.

The total number of SIXCONs to be procured is significantly greater than that of the HALFCONs, primarily due to the large number of FLS Service Support modules to be mounted in these frames. The approximate unit cost, about $2,500, is a little more than half that of of the QUADCON and about $1,000 more than that of the PALCON.

C. MATERIALS HANDLING EQUIPMENT SUBSYSTEM

1. RTFL, 4K

As indicated earlier, the 4K RTFL (Figure V-6) is the sole mechanical means among the FLS equipment for unstuffing 8'x8'x20' containers. In

order for the 4K RTFL to do this, the container must be on a firm, stable surface so that the forklift can readily enter, pick up, and remove palletized unit loads. In most cases, containers would be grounded for this operation. If unstuffing of containers on chassis (i.e., without removal from trailers) is desired, one of two methods may be employed: an earthen platform could be constructed so that the working level of the 4K RTFL is the same as the level of the floor of the trailer; or alternatively, a pit could be excavated into which a trailer could be backed so that the level of the trailer floor is the same as the level of the ground. A third method could be the use of the mobile loading ramp (an Army item) as a means of gaining access to a container on a trailer; however, the Marine Corps evaluated and rejected this item several years ago.

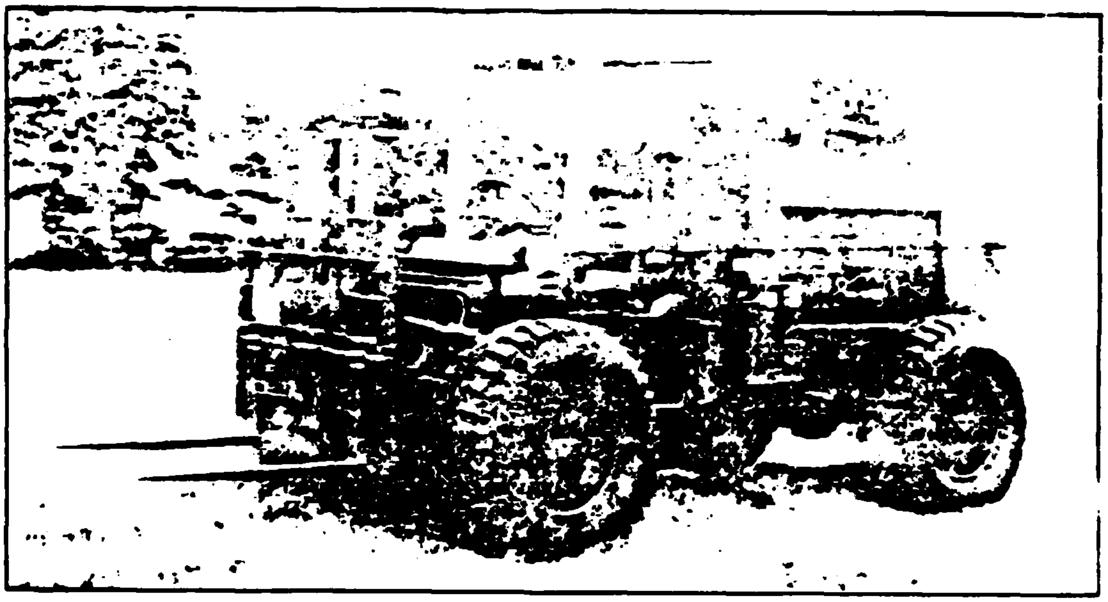


FIGURE V-6.
4K ROUGH-TERRAIN FORKLIFT (RTFL)

The work cycle of the 4K RTFL for container unstuffing is relatively slow, even for an experienced operator. Primarily, this is due to extensive travel required between load pickup and release. For postulated, reasonable conditions, a nominal number of loads to be extracted from each

ammunition container, say 12, the daily production for a 20-hour workday would be about 23 containers unstuffed, or an average of 1.15 container per hour (see Appendix E).

State-of-the art MHE, viz., the shooting-boom forklift truck, exists that could appreciably alleviate the above problems. This item is discussed in Chapter VI.

2. RTFL, 6K and RTFL, 10K

Both the 6K RTFL and the 10K RTFL are used in loading/unloading landing craft in up to 5 feet of surf, conducting materials handling tasks on and across the beach, and loading/unloading logistics vehicles. These machines both provide a versatile material handling capability in various applications in the AOA where four-wheel drive and rough terrain mobility are required. The 10K RTFL can also be fitted with a 2.5 cubic yard bucket for excavation and earth loading tasks, but it will be used extensively as the primary handler of the QUADCON and the shipping frames (HALFCONs and SIXCONs) discussed above.

3. LACH, 22.5 ton

The LACH (Figure V-7) is a two-wheeled, hydraulically-operated straddle carrier that provides a capability to offload fully loaded 8'x8'x20' containers from beached landing craft. As indicated, the LACH requires a separate prime mover, a medium-crawler tractor, to provide mobility. It can be maneuvered through up to 5 feet of surf to pick up the containers; on the shore it can deposit containers either on the ground or directly into logistics trailers for movement inland.

The LACH, RTCH and the Navy-operated elevated causeway (ELCAS) are the designated means for discharge of 8'x8'x20' containers in LOTS operations. Depending on the discharge rates, availability of equipment/personnel, or other circumstances, these means may be used simultaneously or individually. LACH throughput capacity is currently rated at 120 containers per day (cpd) for a 20-hour workday [Ref. 11]; the total number of LACHs allocated to the MAF is 11, as indicated in Chapter III. (As a matter of interest, Reference 11 also indicates that the

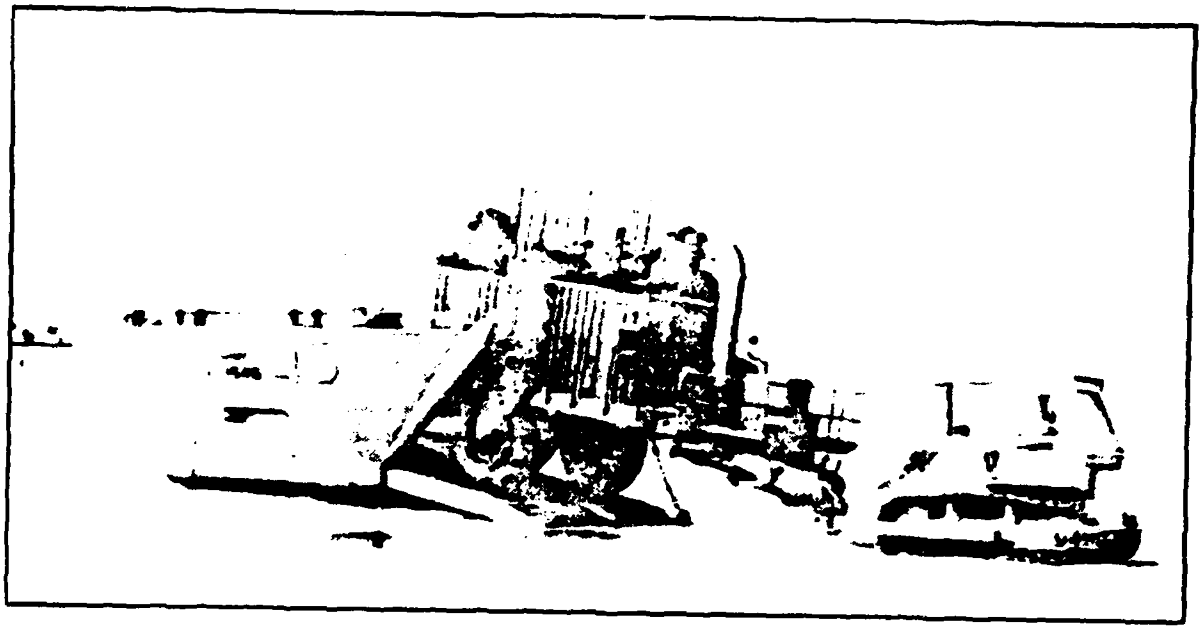


FIGURE V-7.
LIGHTWEIGHT AMPHIBIOUS CONTAINER HANDLER (LACH)

throughput capacity of the ELCAS is 600 cpd for a 20-hour workday and that there will be two ELCASs designated for support of each MAF. Further, Reference 12 states that "since the ELCAS provides a faster and less cumbersome operation than the LACH, it is likely that a great majority of the containers will be handled by it.")

Although the LACH provides a utilitarian means for offloading containers from beached LCM-8 and LCU landing craft, it has several drawbacks that may have an adverse influence if it were the only means for bringing containers across the beach. Each LACH, of course, ties up a crawler tractor; if the distance that containers are to be moved is very great, cycle times would be extended due to the relatively slow speed of movement. Also, under adverse weather and/or limited visibility conditions, maneuver time while backing, particularly to position a container on a logistics trailer, would undoubtedly introduce a delay factor into the operation. Finally, the performance characteristics of the LACH (which may be optimistic) have been extrapolated from operations such as SOLID SHIELD 79

[Ref. 14], which tabulated a relatively small number of work cycles with empty containers and did not entail extended, repetitive operations with fully loaded containers under simulated tactical conditions.

Technologies exist that could provide self-propelled straddle carriers that have mobility and maneuver characteristics far superior to those of the LACH. These are discussed in Chapter VI.

4. RTCH, 50,000 pound

The RTCH (Figure V-8) is a four-wheel drive, rubber-tired, diesel-powered articulated-steer tractor capable of lifting, transporting, transferring, and stacking (two high) ISO containers with a gross weight of 50,000 pounds. Although the RTCH can handle ISO containers or shelters of various lengths (20', 35', or 40'), of concern here is the 8'x8'x20' container that is used for intertheater movement of ammunition. The RTCH is a rough-terrain vehicle and will be the primary ammunition container handler at container transfer points, marshaling yards, and container storage areas wherever these facilities are established within the AOA.

Based on its essentiality relative to the efficient handling of large containers in an AOA, the RTCH must be able to perform reliably and predictably under whatever conditions may be encountered. An issue that has arisen concerns the true ability of the RTCH to operate with fully loaded containers on unimproved surfaces. Two documented sources produce somewhat conflicting findings:

- TRADOC Combined Arms Test Activity (TCATA) Test. The TCATA test report, Container Related Materials Handling Equipment in Ammunition Companies [Ref. 15], found that "the RTCH...was able on all surfaces to lift, move, and emplace a fully loaded container." This test was conducted in a simulated field environment consisting of both an improved ammunition container storage pad (surfaced) and one that was unimproved (nonsurfaced dirt).

  In the case of the unimproved pad, the test did find that the RTCH became stuck after it had made repeated passes in the

same path; it took a D-7 bulldozer one hour to repair the damage. Also, the ruts made by the RTCH in multiple passes created trafficability problems for the 4K RTFL, which would be operating in the same area.

When the unimproved pad was configured with the containers stored in a herringbone pattern, no rutting or trafficability problems were encountered, since the RTCH could move and place containers without repeated passes over the same ground. (However, the report did not elaborate on the implication of this technique, viz., that the herringbone pattern would accommodate fewer than one-third of the number of containers that could be stored in the same space using the standard configuration, i.e., side-to-side pattern.)

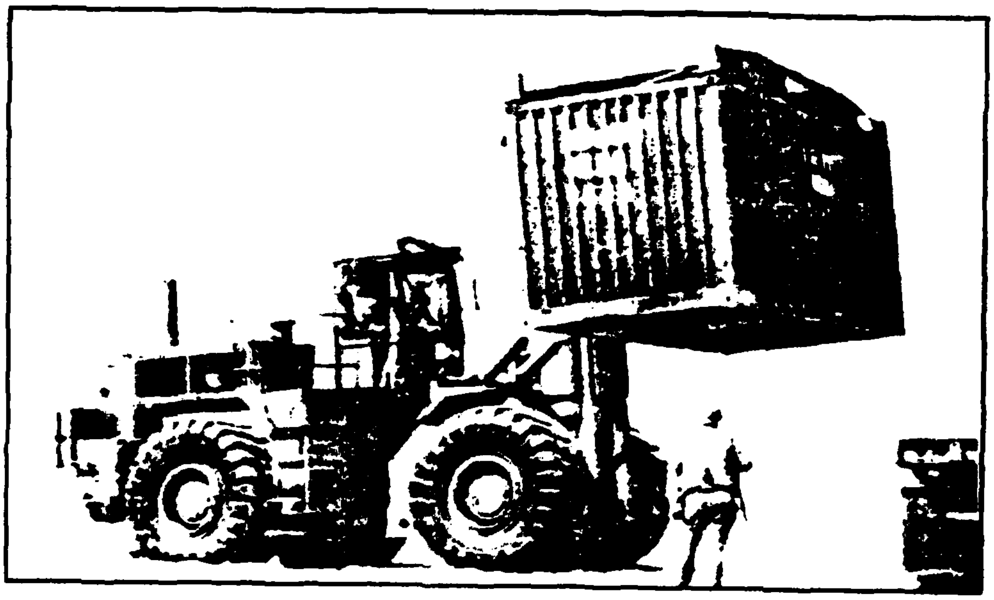


FIGURE V-8.
50,000-lb ROUGH-TERRAIN CONTAINER HANDLER (RTCH)

- Naval Civil Engineering Laboratory Report. A recent NCEL report [Ref. 16] that addressed container marshaling (general cargo) in a CSSA concluded that the RTCH is not an optimum container handler for Marine Corps requirements." This report noted that the RTCH can "produce severe pavement maintenance problems when operating on paved surfaces not specifically designed for the machine" and for multiple pass operations on unsurfaced areas "would increase the engineer effort expended to upgrade soil strength through either stabilization, surfacing, or placement of

a structural fill." However, as noted also in the TCATA test, the report does concede that RTCH "is relatively mobile on unsurfaced soils for single-pass or low-traffic conditions."

The NCEL report also concluded that the DROTT 2500 (i.e., 30-ton RTC, discussed below) is not an "optimum container handler" either, primarily due to weight lifting limitations and "inefficiency of operations" since it cannot move containers from place to place. One of the principal recommendations of the NCEL report is that "a marginal terrain straddle lift container handler be selected as a container handler for use in a CSSA."

Notwithstanding the favorable TCATA test report, a spokesman for MMCS has indicated that MMCS does not want the RTCH assigned to its general support (GS) ammunition units. The minutes of the Fall 1983 HELFAST Ammunition Seminar [Ref. 17] includes the text of an MMCS briefing that states: "It has long been recognized in the ammunition community that the 50K RTFL is not desirable for container handling within ammunition units due to size, weight, and maneuverability requirements for equipment in ammunition supply operations." The briefing concludes that "the 50K RTFL is a large, cumbersome piece of equipment that does not adequately meet the needs of containerized ammunition handling and cannot be effectively utilized in this capacity" and recommends that "the RTCH not be issued to ammunition units and expeditious action be taken to identify, test, and procure a light, mobile container crane that will accommodate ammunition requirements."

Conversations with personnel in the field, i.e., visits with members of the 2d FSSG at Camp Lejeune [Ref. 18] and the U.S. Army 119th Container Handling Company at Fort Eustis [Ref. 19], produced observations that "the RTCH seems to be unstable (front-heavy) with fully loaded containers," that "the RTCH has great difficulty operating in sand with full containers" and that "there is a serious question concerning day-in/day-out continued operations of RTCHs on soft ground with heavy ammunition containers." Although undocumented, these comments reflect concern at the working unit level, or at least a perception that the RTCH may have serious shortcomings under conditions such as those that may be encountered in an AOA. However, it should be noted that the RTCH is still a candidate container handler.

Currently, it is the only militarized handler available to the Services. It was declared the preferred means to transfer containers during the 1984 J-LOTS exercises.

The major issue concerns RTCH effectiveness on unimproved surfaces and on sand with fully loaded ammunition containers. It appears that the RTCH is operable under such conditions if usage patterns and container storage configurations can be arranged in a manner that minimizes multiple passes over the same ground. However, some operational efficiency may be sacrificed by this condition.

The self-propelled straddle carriers, mentioned above under the LACH and noted in the NCEL report, could provide mobility characteristics and handling flexibility superior to that of the RTCH. These are discussed in Chapter VI.

5. RTC, 30 Ton

The 30-ton RTC (Figure V-9) is a versatile piece of equipment that can be used not only for container handling but also for surfline loading/unloading operations, clamshell bucket operations, pile driving, bridge/raft/prefabricated building/control tower erection, and various other crane/winch/hydraulic applications. Due to low boom ratings at shallow angles, the RTC can only handle empty or lightly loaded containers; thus, its use for handling containerized ammunition would be extremely limited.

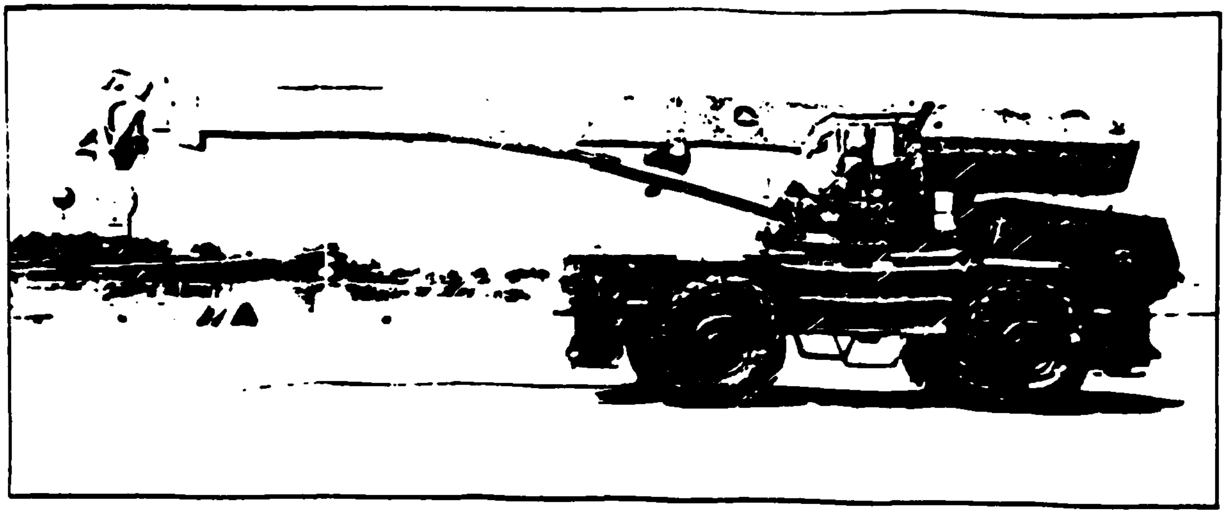


FIGURE V-9.
30-ton ROUGH-TERRAIN CRANE (RTC)

D. MOTOR TRANSPORT SUBSYSTEM

1. HMMWV, 5/4 Ton

The HMMWV, as indicated in Chapter III, is found at all levels of MAGTFs; it, of course, was not intended to play a major role in ammunition resupply. However, should the PALCON be modified with inserts, as suggested above, to accommodate bare rounds or tailored ammunition loads, possible use of the HMMWV as an expedient ammunition transporter would provide added flexibility to the resupply system.

2. HHMTT, 5 Ton

The HHMTT can be used to transport ammunition from Class V(W) ASPs to using units, normally in the form of palletized unit loads. As indicated in Chapter III, most of the HHMTTs are found in the motor transport support elements of the MAGTF. The HHMTT is also the prime mover for the M198 in the artillery regiment. As indicated earlier, the artillery regiment TE includes 148 HHMTTs and 1-1/2 ton trailers that are dedicated as ammunition carriers, and the tank battalion has 24 HHMTTs that are primary ammunition vehicles.

The cargo bed of the HHMTT has drop sides, thus enabling it to easily accommodate either small or intermediate FLS containers (e.g., QUADCONs or PALCONs) as well as the current wooden ammunition pallets.

3. MK48-Front Power Unit (FPU)

The key component of the Marine Corps LVS, which is part of the FLS, is the MK48-FPU (Figure V-10) that hauls a variety of RBUs tailored for specific applications. The LVS design is such that all MK48/RBU combinations will have an 8x8 power distribution, thus providing superior off-road traction and mobility. Of interest here is the excellent capability provided by the LVS to transport dimensionally standard ISO ammunition containers and large quantities of breakbulk cargo under most conditions encountered in a primitive AOA.

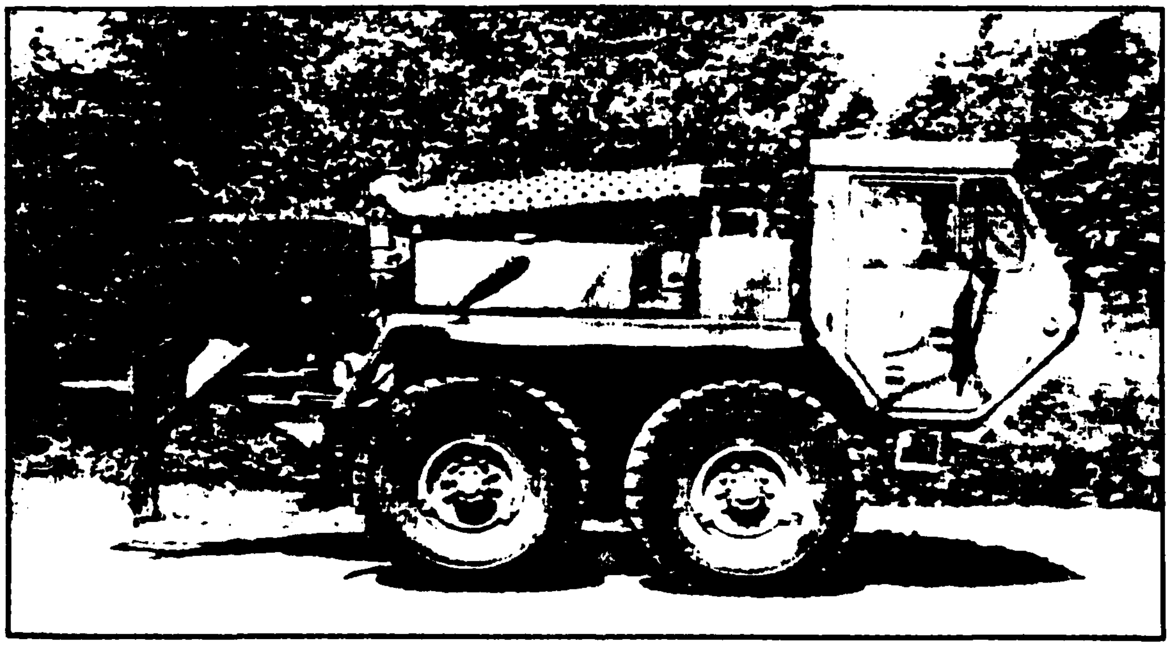


FIGURE V-10.
LOGISTICS VEHICLE SYSTEM (LVS), MK 48

4. MK14 Container Hauler RBU

The MK14 container hauler (Figure V-11), powered by the MK48, is the primary transporter of 8'x8'x20' containers, shelters, and other FLS modules. It has a cargo hauling capacity of 22.5 tons on the highway and

12.5 tons cross country. In addition, a second MK14 can be towed in tandem behind a fully loaded MK48/MK14 configuration, but with a reduced cargo load.

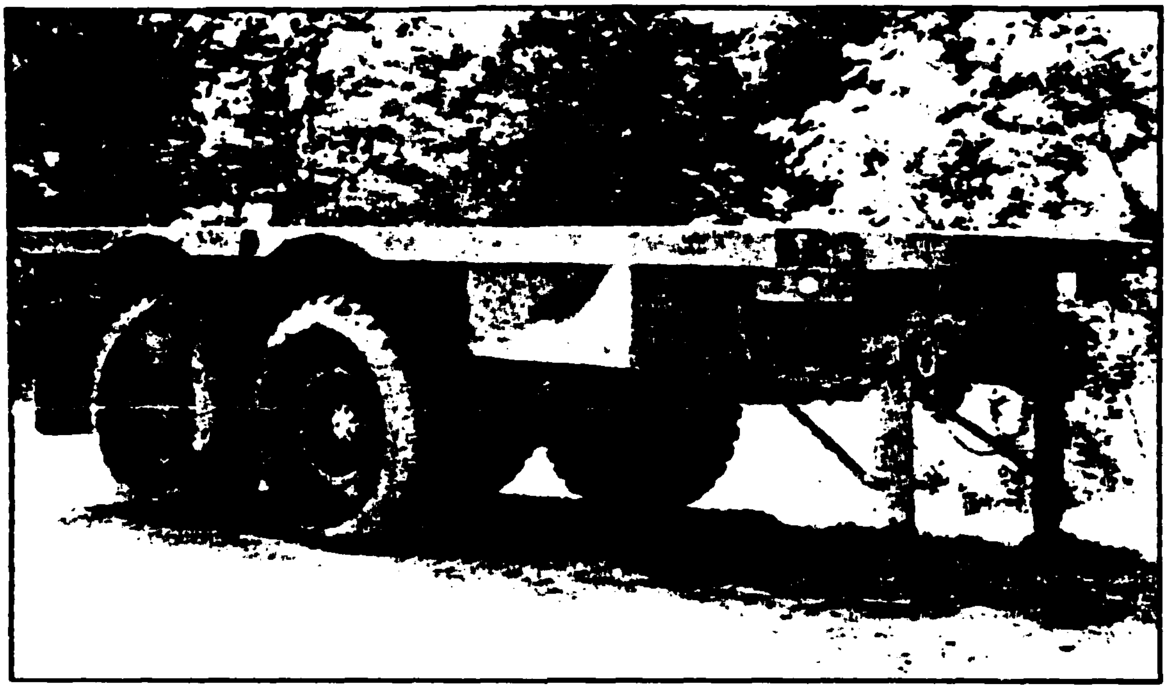


FIGURE V-11.
LOGISTICS VEHICLE SYSTEM (LVS), MK 14

5. MK17 Dropside Cargo RBU

The MK17 dropside cargo RBU (Figure V-12), powered by the MK48, is designed primarily for the resupply of ammunition in a combat service support role. It has a cargo capacity of 20 tons highway and 10 tons cross country; also, the MK17 has an onboard crane with a lifting capacity of 9,000 pounds. The MK17 is eminently suitable for carrying ammunition pallets or QUADCONS between ammunition storage/supply facilities or to using units.

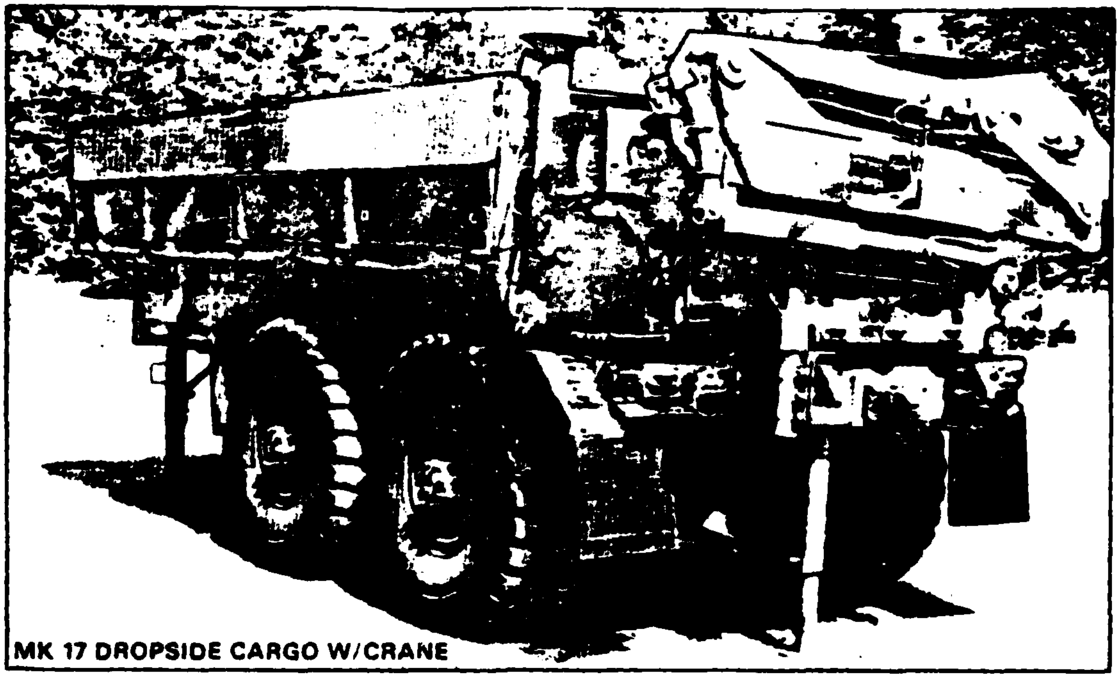


FIGURE V-12.
LOGISTICS VEHICLE SYSTEM (LVS), MK 17

E. SUMMATION

The FLS components discussed above are considered to provide the Marine Corps with the types of resources necessary to deal with and take advantage of the containerization of ammunition in an AOA. This assessment considers containerized ammunition from two levels:

- Wholesale - the ability to receive ammunition containers in "wholesale format," i.e., 8'x8'x20' intermodal ISO containers, and to control, handle, and transport these containers within an AOA.
- Retail - the ability to convert containerized ammunition from a wholesale format to a "retail format," i.e., store and unstuff the ISO containers, and issue ammunition to using units based on resupply needs.

The above assessment, however, is made with several caveats:

- Containers
  - -- Although the 8'x8'x20' ISO container is an approved, functional means for unitizing large quantities of ammunition, open flat rack containers (discussed in Chapter VI) offer the potential of providing more efficient intermodal shipment and better accessibility to contents within the AOA.

-- The FLS small and intermediate containers seem to be better suited for nonroutine than for routine ammunition resupply operations. However, the provision of specialized honeycomb inserts for ammunition packing within PALCONs and QUADCONs (commensurate with compatible ammunition packaging) would permit full exploitation of these containers on a routine basis on the retail level.

- Materials Handling Equipment

-- The relatively low daily productivity and potential problems regarding container access may make the 4K RTFL less desirable as an ammunition container "unstuffer" than other available means.

-- The fact that the LACH ties up a medium tractor in order to operate, has limited mobility, and has questionable productivity under realistic conditions makes it a less-than-optimum piece of equipment for offloading containers across the beach (especially if no other means are available).

-- The RTCH can be an effective and efficient container handler on unimproved surfaces provided that usage patterns are established to avoid repetitive passes along the same paths and that less efficient container storage configurations are acceptable.

VI. TECHNOLOGY ASSESSMENT

A. GENERAL

In view of the observations in the preceding chapter concerning the efficacy of various components of the FLS and the study guidance to "look at state-of-the-art equipment," this chapter identifies and briefly describes specific items at various stages of development that might influence or provide improved capabilities in implementing a containerized ammunition concept in the AOA.

Succeeding paragraphs discuss each of the following items, in turn, in the broad categories of containers and MHE:

- Containers
  - -- Flat racks
  - -- Unit load container
  - -- U.S. Army ammunition packaging initiatives
  - -- Container identification and control
- Materials handling equipment
  - -- Straddle carriers
  - -- Self-loading container haulers
  - -- Shooting boom forklift truck
  - -- Slip sheets.

B. CONTAINERS

1. <u>Flat Racks (Projects Easy ISO/Commando Rack)</u>

The U.S. Air Force, principally Headquarters, Pacific Air Forces (PACAF), has been involved in testing and evaluating various concepts for air munitions containerization for over 10 years. These efforts have culminated in the establishment of projects Easy ISO and Commando Rack [Ref. 20].

a. Project Description

The purpose of Easy ISO was to validate the use of intermodal flat racks, of the sizes shown in Figure VI-1, as air munition transport units. Commando Rack is a PACAF project to test various air munitions loads for feasibility throughout the supply cycle, i.e., placing munitions on the racks at plants/depots/ports, loading racks on oceangoing vessels, offloading vessels, handling loads in theater, and removing munitions from the racks. Planning is under way to conduct a comparison test between flat racks and enclosed containers in Europe in the summer of 1984, using 25 of each.

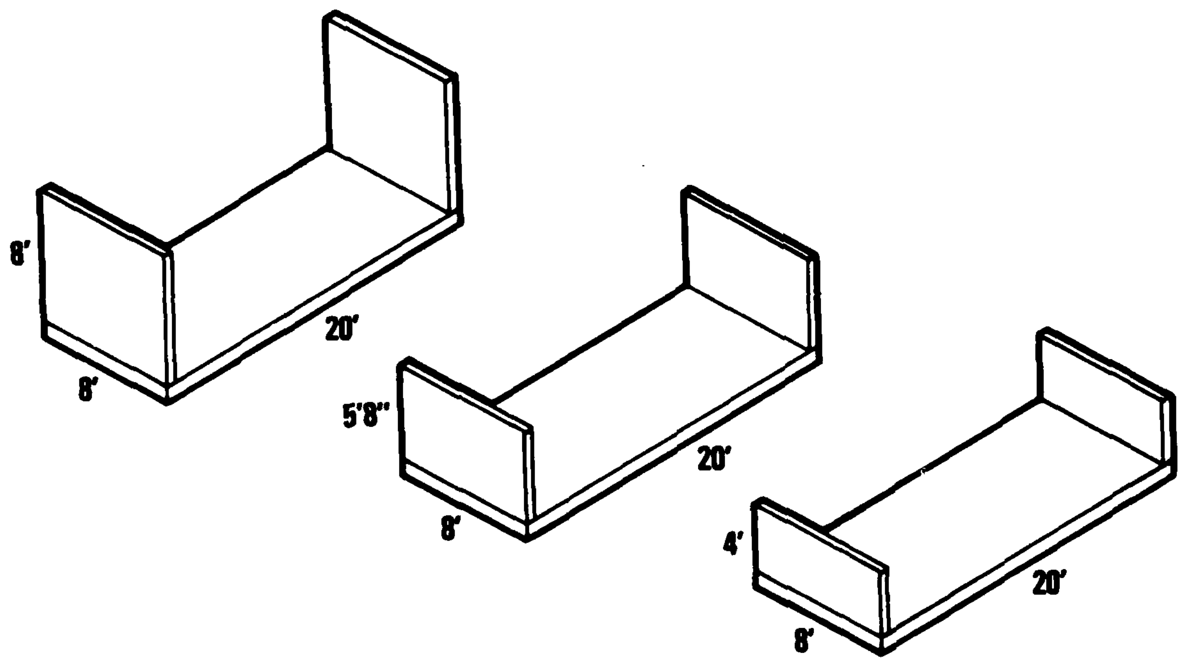


FIGURE VI-1. PROJECTS EASY ISO/COMMANDO RACK

The sizes of the flat racks shown are those that are commercially available and are compatible with the configurations of the variety of air munition loads required. Two-inch steel straps and 2'x4' and 2'x6' lumber are used to make up the restraint system. Rails and posts also are used but are not required as a structural part of the restraint system. A feature of the flat rack is the ability to fold down the ends to reduce the cube for retrograde movement. When stacked empty in this manner, an 8'x8'x20' flat rack has a five-to-one cube advantage over an enclosed container.

b. Flat Rack Stowage on Containerships

The potential advantage of flat racks for containership stowage is illustrated in Table VI-1. The table (derived from Reference 21) shows, as a base case, 300 ISO containers, 8'x8'x20', each with a payload of 16 tons. The total available vertical height of hold space is assumed to be 2,400 feet. However, since for many cases ammunition will weigh out before it cubes out, there will be inefficiencies in use of the available space.

TABLE VI-1. CONTAINER/FLAT RACK COMPARISON

	Height*	Number	Payload (Short tons)	Percent Increase
ISO container	8'	300	4,800	-
Flat rack mix options				
A	8' 5'8"	200 141	5,456	14
B	8' 5'8" 4'	150 75 151	6,016	25
C	8' 5'8" 4'	100 141 200	7,056	47

*Containers and flat racks will have a base of 8'x20'.

Options A, B, and C portray mixes of flat racks [illegible] shown, each with a 16-ton load tailored to maximize the available cube. Each option occupies the same 2,400-foot total vertical height.

The increase in payload per ship can also be expressed in terms of savings in number of ships required. Thus, a convoy of 10 ships for the base case would be equivalent to the following number of shiploads for the three options indicated:

- Option A: 8.75 shiploads
- Option B: 8 shiploads
- Option C: 6.67 shiploads.

c. <u>Project Commando Rack Test Results</u>

In tests completed by the 400th Munitions Mainenance Squadron, PACAF, the Air Force has designed packing configurations (to include manhour labor estimates and bills of materials) for loading and bracing a variety of air munitions on flat racks having end walls of varying heights [Refs. 22 and 23]. In many cases, e.g. for the MK84 general purpose bomb, for cluster bomb units in a variety of shipping containers, and for the AIM-9 missile in the CNU-310/E container, current procedures provide only for breakbulk shipping for intertheater movements. Unitizing these munitions on flat racks has been found to offer significant potential advantages in increased throughput and decreased handling and shipping costs.

With the assistance of DACS, the Air Force already has obtained certification of the flat rack for shipment of 30-mm rockets from the AAR and the U.S. Coast Guard (USCG). Shipping configurations using the 5'8" high rack have been developed for the MK82 500-pound bomb with either the MAU93 or MK15 fin and for other munitions as well. As an example of improved efficiency, 18 Rockeye cluster bombs can be shipped on a flat rack versus only 12 in an enclosed 8'x8'x20' container.

d. Flat Rack Advantages/Disadvantages

As indicated above, the potential advantages of flat racks overall are numerous. Some of the more prominent ones identified by the Air Force [Ref. 20] that are germane to this study include:

- Accessibility. Either lateral or vertical access is readily achievable by forklift or crane. Flat racks are equally accessible in transit or at storage areas.
- Ease of loading/unloading. Openness of the munitions load area allows for adjustments with minimal constraints.
- Specialized MHE not required. The need for special handling equipment is minimized due to open access to munitions loads.
- Greater cube use. Flat racks allow container selection of varying heights, thereby permitting more efficient use of space.
- Increased vessel capacity/capability. Better cube use and container height selection make additional container space available on each ship; flat racks are stackable.
- Packaging flexibility. More varied load packages can be used with flat racks. (Elongated missile containers are now viable candidates.)
- Ease of retrograde. Collapsible flat racks minimize the burden of returning them empty to points of origin.
- All-service adaptability. Each service has munitions of the density to make flat rack use an asset.
- Timely implementation possible. Flat racks could be readily available and require no new or elaborate equipment.

On the other side of the coin, however, the advantages noted relative to open access to munitions loads could become disadvantages, if security and environmental protection are of major concern. This is especially true if intermodal containers are to be used for extended periods for field storage. However, open flat racks are not much different from current procedures for open storage of breakbulk ammunition. Should some type of cover or protection be desired for flat racks, several alternatives are feasible: high-strength stretch wrap could be applied at the source as protective covering and/or to secure munitions loads to pallets; tarpaulin or other types of covering could be used enroute or in storage on an expedient basis; or a lightweight, readily detachable upper body unit (similar to that which comes as part of the MGB container, described in Chapter V) could be designed as part of the flat rack system.

AD-A166 502 US MARINE CORPS CONTAINERIZED AMMUNITION SYSTEMS STUDY (1985-1995)(U) SYSTEM PLANNING CORP ARLINGTON VA R J YEOMAN JUL 85 M00027-83-R-0033

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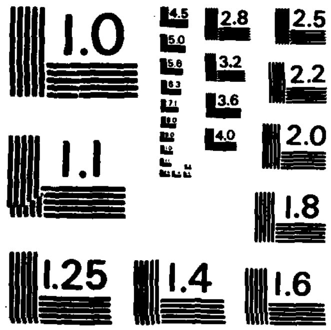


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Within an AOA, the use of flat racks would greatly facilitate both the wholesale and retail aspects of dealing with containerized ammunition:

- A flat rack can be emptied of its contents by any forklift or crane, or combination, that has the capacity to lift individual loads; this is true whether the flat rack is up on a container hauler (i.e., MK14), on the ground, or stacked in a storage area. A key aspect of this flexibility is that the need for container handlers (i.e., RTCHs) could be reduced or even eliminated at specific locations, depending on workload and equipment allocations.
- The flat rack can be used efficiently for multiple ammunition pallet unitization (configured loads) for onward movement by motor transport or helicopter to using units.
- Likewise, the openness of the flat rack would facilitate efficient "downloading" (i.e., rapid removal of some of the contents) in the beach area should onward movement of container haulers be restricted to cross-country travel (no improved roads available).
- Once the flat racks have been emptied and are to be stored until retrograde begins, only one-fifth of the storage space required for empty standard ISO containers would be necessary. Likewise, during retrograde, the requirements for container handling equipment and motor transport would be commensurately less as well.

2. British Unit Load Container

The UK has developed a versatile ammunition container, the ULC, which is sealable to give maximum protection to unit quantities of ammunition--both in storage and in transit (Figure VI-2). This container is made of steel and has been designed to conform to applicable NATO tolerances and standards. Approximate exterior dimensions are 54" high x 42.5" wide x 51" long, and the empty weight is 300 kg, or about 660 pounds. The ULC is designed for a maximum payload of 1,000 kg, or 2,200 pounds. According to the manufacturer, the unit price is on the order of $850 (about half the cost of the PALCON). The manufacturer also advises that the ULC can be made to whatever size a customer desires; the configuration described here is that fielded by the British Army and being tested by Canada and Australia.

An especially attractive feature of the ULC is the ability to accommodate a variety of honeycomb inserts tailored for specific types of ammunition, as illustrated in cross-section in Figure VI-3. These inserts are

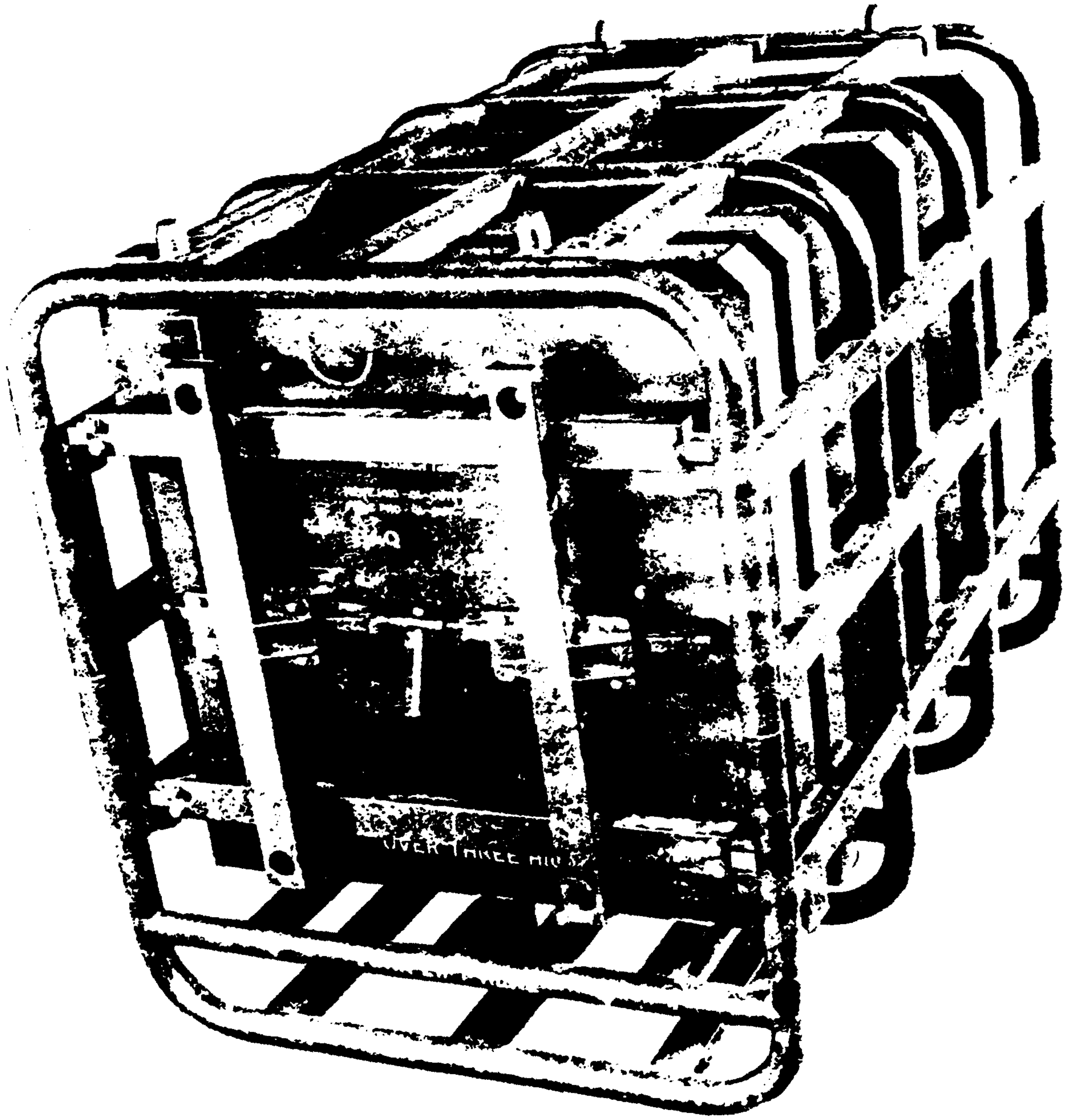


FIGURE VI-2. UNIT LOAD CONTAINER

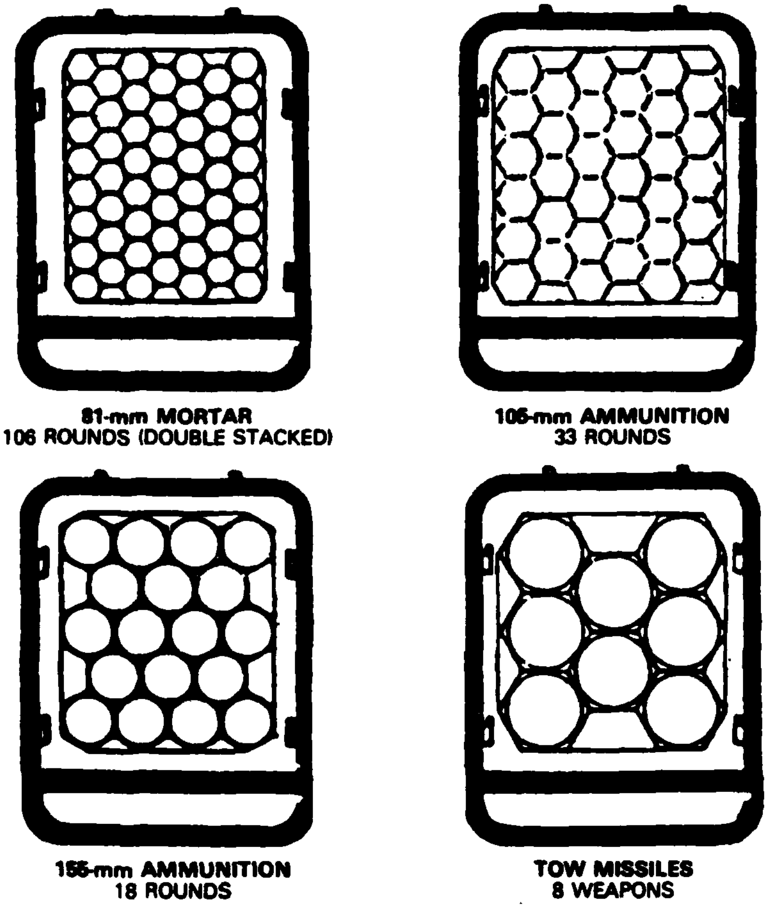


FIGURE VI-3.
UNIT LOAD CONTAINER INSERTS

detachable, if desired, and are made of lightweight sheet steel. The outside dimensions of the inserts shown are about 41" high x 38.5" wide x 44" long; internally the honeycomb pattern can be modified to accommodate other items as well, such as rifles, radio equipment, or other sensitive cargo. The removable door provides a hermetic seal when closed and permits ready access to all contents when removed.

The tubular steel frame is intended to provide for easy handling and maximum protection during transit. The frame has built-in sling points for easy lifting by crane or helicopter. It also has stacking lugs that permit two-high stacking for safe lifting and movement by RTFLs and rigid four-high stacking for field storage.

The UK concept envisions packing the ULC at the munitions plant and using it as the principal shipping/storage container throughout the entire logistical network to the battlefield user. The forward area benefits of the ULC are the delivery of bare rounds to the user, thus enabling faster rearming of combat systems (for example, over three times faster per round for replenishing the stowed ammunition load in a tank), and elimination of the battlefield debris caused by unpacking munitions from fiber canisters and wooden boxes/pallets. The AITF report [Ref. 23] found that the unpacking of 100 105-mm tank rounds generated about one ton of debris occupying a volume of some 200 cubic feet.

A major consideration, however, is the how and where at which the ULCs are to be packed, retrograded, and repacked. For the midrange time frame it would appear that packing at ammunition plants would not be possible, unless the U.S. Army in its "lead service" role [Ref.13] designated the ULC (or equivalent) as a standard unitization module for containerization of selected items. Options, controllable by the Marine Corps, include: (1) reconfiguring ammunition loads into ULCs at CONUS bases or ports so that ULCs could be deployed with operating forces in the form of basic allowances, LFORM, and/or mount-out stocks, (2) reconfiguring PWRMS in overseas Naval magazines into ULCs for movement into the AOA, or (3) reconfiguring palletized ammunition into ULCs in ammunition storage areas or ASPs within the AOA for issue to using units. All of these options would result in additional costs and workloads for the Marine Corps. The third option would entail changes and additional workloads in current procedures/operations for ammunition resupply in an AOA (as discussed in the previous chapter relative to PALCONs/QUADCONs). Additional significant logistics would result from a requirement to retrograde ULCs for re-use, and some detailed analysis would be needed to determine whether the ULCs should be handled as re-usable or disposable assets.

3. U.S. Army Ammunition Packaging Initiatives

Recent Army initiatives, as outlined in its recent Action Plan for Ammunition Packaging [Ref. 24], are worthy of mention because of the potential impact on Marine Corps operations. The specific goals of these new initiatives are:

- 25 to 40 percent reduction in packaging cube per round
- 20 to 30 percent reduction in packaging weight per round
- Reduction of battlefield debris and signature
- Safer storage of high explosives and propellants
- Ease of decontamination
- Easy access to ammunition
- Protection from biodeterioration and corrosion.

Two of the current, directed actions in this program involve 155-mm artillery ammunition [Ref. 25]:

- Lightweight Propelling Charge Container. The current heavy metal containers currently used to ship and store the various types of propelling charges are such that the containers themselves comprise anywhere from 46 to 83 percent of the total shipping weight. The proposed solution (Figure V-4) envisions lightweight plastic or metal specially molded containers that can be arrayed in a 5 by 6 configuration on a 40"x48" (approximate) pallet. The payoffs will be a 20 percent cube reduction, a 30 percent weight reduction, increased numbers of propelling charges per pallet, and significant savings in transportation costs (all modes). The projected fielding date is FY 87.
- Ready Rack, 155-mm Projectile. The 155-mm ready rack, made of lightweight plastic or metal, would replace the current wooden pallet (see Figure VI-5). Among the major advantages of the ready rack will be individual round accessibility, nuclear, biological, and chemical (NBC) protection, safe transport of fuzed rounds at battery level, compatibility with resupply vehicles, and convenient nesting of multiple racks when removed from pallets. The projected fielding date for this item is also FY 87.

Also included in the 40 or so R&D projects in this program is the provision of a lightweight plastic or metal container for the 120-mm tank round. The goal is to provide better accessibility, as well as the weight/cube reductions that are the principal goals of the program. This item is projected for fielding in FY 90.

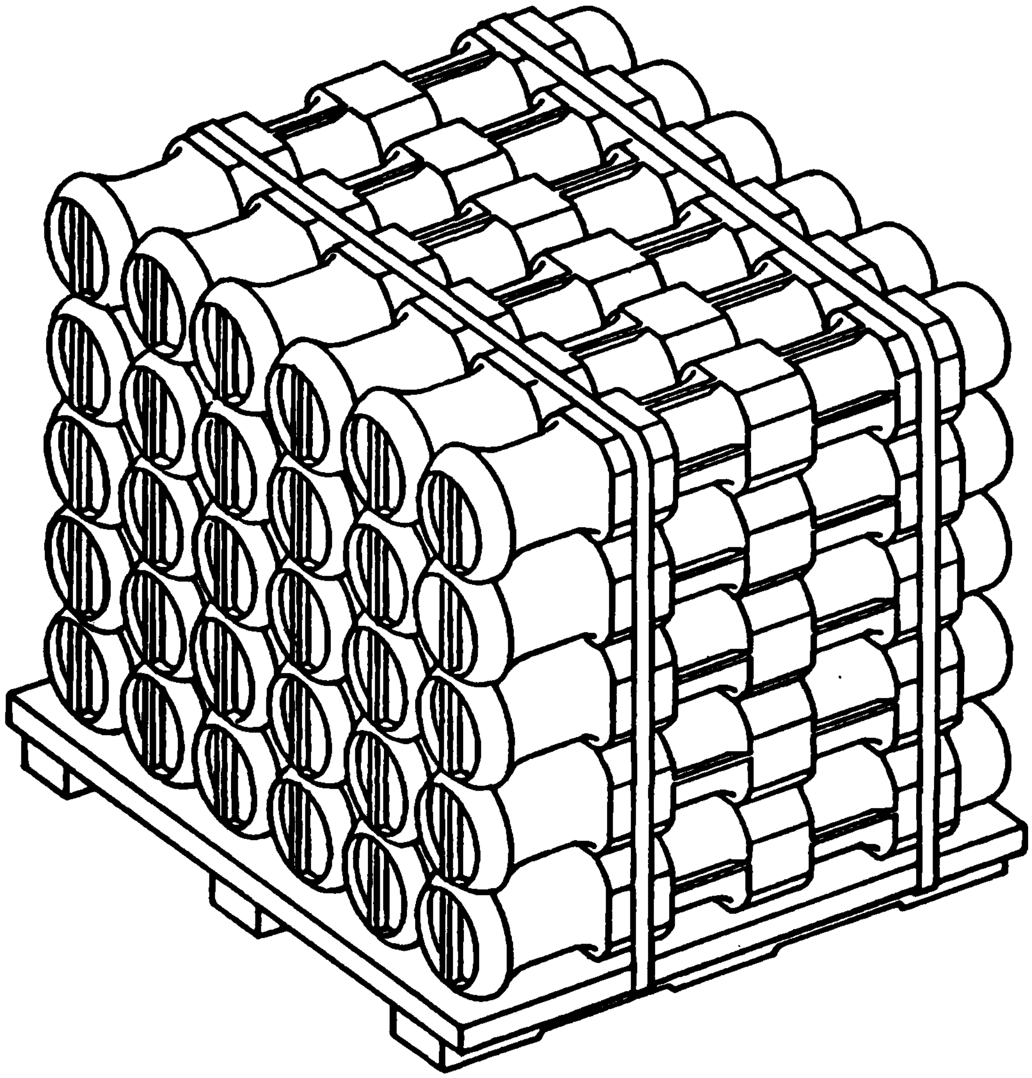


FIGURE VI-4. PROPELLING CHARGE CONTAINER, 155 MM

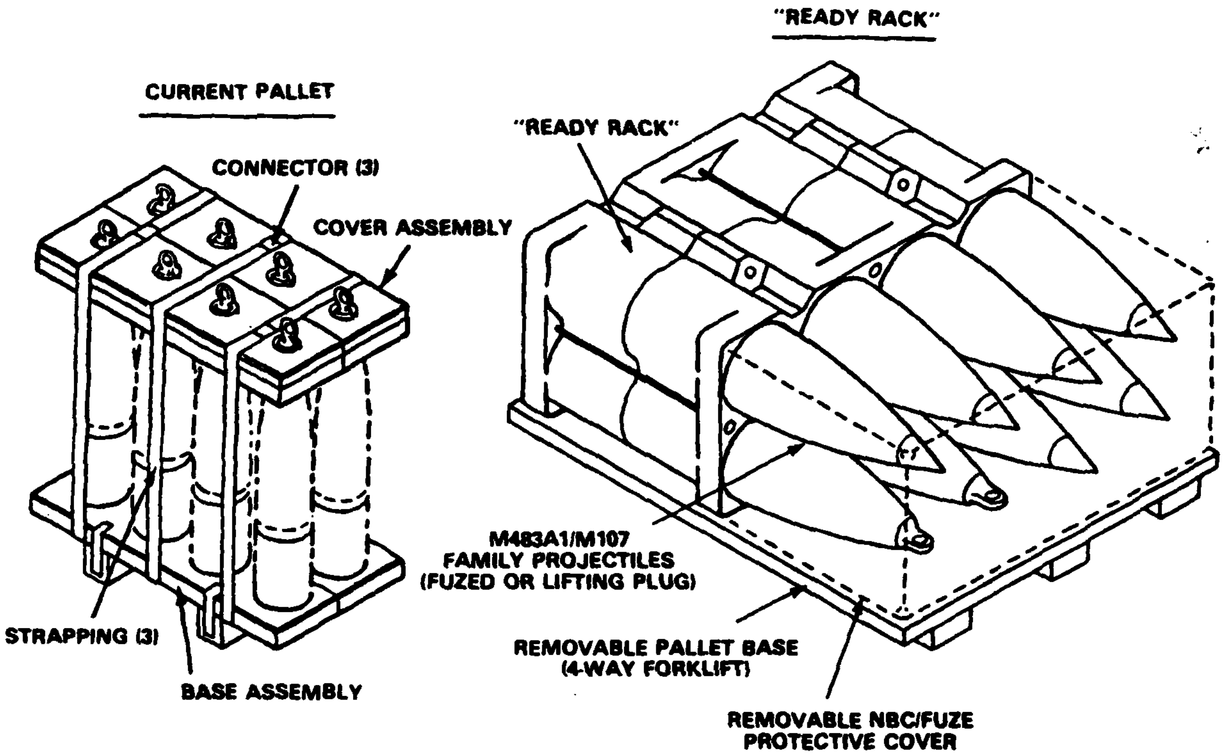


FIGURE VI-5. IMPROVED 155MM PROJECTILE PALLETIZATION

A major thrust of these Army initiatives is to package ammunition so that it can move through the resupply network as far forward as possible in the original package/container. The implication of this trend is that operations in the future in overseas theaters (and AOAs) will become more efficient and more amenable to containerization/unitization. However, the reality is that across-the-board impacts won't be felt for a long time. For most of the midrange period, based on continued production and world-wide storage of thousands of tons of conventional ammunition packaged in fiber canisters and wooden boxes (i.e., as it exists today), the situation will not be significantly different.

4. Container Identification and Control

The issue of cargo monitoring (to include container identification and control) enroute to and within an AOA and the status of various systems that have been developed, or are under development by the military services and industry, are very thoroughly covered in two recent reports prepared for the Marine Corps by Northrop Services, Inc. [Refs. 26 and 27]. The first report provides an evaluation of a number of identification/monitoring systems from the point of view of potential applicability to supporting the AFOE of a MAF; the second recommends remedial courses of action to correct perceived problems. The intent of these efforts was to focus on those systems that have the capability of providing a Marine Automated Cargo Throughput Documentation System (MACTDS), i.e., an automated tracking system that identifies a container and cargo contents from point of origin through offloading and distribution within an AOA.

Cargo monitoring encompasses two separate but interrelated functions: first, traffic management of the containers; and second, supply inventory management of the containers and their contents. The first function is fulfilled by assigning identification numbers to the containers so that they can be tracked and/or directed to their destinations in the AOA where they will eventually be unstuffed. The second function entails provision of a listing that identifies (usually by National Stock Number (NSN)/DODIC) each item in each container and the quantity. Since, as indicated previously, for Class V there will be a relatively small number of items per container, the supply inventory management function should be much less complex than it would be for those classes of supply with many different items of varying quantities in a container.

The Northrop analysis examined the problem from two viewpoints--a cargo monitoring system that is normally automated and can also function effectively in a manual backup mode and a full up computer supported MACTDS. In the latter case, it was found that any of four deployable computer systems (two Marine Corps and two Army) can do the job, but the "Marine Corps ADPE-FMF 'green machine' (was) recommended as the first choice...if the MPS and JLOTS II Phase III test results are favorable."

However, the bottom line of the Northrop report is that detailed system requirements still need to be defined and that a required operational capability (ROC) for the MACTDS should be prepared before meaningful tradeoff analyses and full-scale development can begin.

However, from the viewpoint of a dual manual/automated system, the Northrop report identifies three compatible systems that would appear to be eminently suitable for monitoring containerized ammunition in an AOA--two manual and one automated:

- Color Code Cargo Identification System. The simplest manual system would be use of different colors representing each class of supply displayed on a readily visible location on the container, e.g., yellow for Class V. Further distinction could be made by using shapes for additional subclassification, e.g., a yellow circle for Class V(W) and a yellow triangle for Class V(A).
- Numerical Code Cargo Identification System. Under Military Standard Transportation and Movement Procedures (MILSTAMP), a transportation control number (TCN) is used to identify all shipping units, or containers. The TCN is a 17 digit number that includes identification of shipping activity, date, shipment code, and serial number. The last three digits are not normally used for substantive information and could be used to provide additional information on container contents. (Implementation of this technique for improved container monitoring, however, would require approval of a modification to MILSTAMP.) For example, 5WC could be used to designate Class V(W), storage category C, and 5AD could be used to designate Class V(A), storage category D. If the TCN inscription on the container is too small to be read from a distance, the last three digits could be stenciled in large characters so that they could be seen readily.
- Logistics Application Automated Marking and Reading Symbology (LOGMARS). The LOGMARS system consists of:
  - -- A bar code label affixed to the container or item to be identified
  - -- A portable scanning device that reads the bar code and records the reading in a small, portable microprocessor
  - -- A communication/conversion unit that transmits the microprocessor output to a host computer
  - -- The host computer itself, which provides a usable readout of logistics information to the operator.

  The LOGMARS equipment is compatible with the ADPE "green machine." The Marine Corps and other services are already using

bar codes to identify, track, and inventory numerous items, including ammunition pallets. Also, the modified TCN manual system is readily adaptable to the LOGMARS bar code system. LOGMARS is scheduled for evaluation and test in MPS offload and Joint Logistics Over the Shore (JLOTS) II Phase III tests this year.

A combination of all three of these systems would probably be the optimum choice for application across-the-board to all classes of supply coming into an AOA. For ammunition, based on the relatively easier supply management problem for Class V, a combination of the two manual systems (color and modified TCN coding) could provide sufficient identification means in an AOA for proper, rapid routing of containerized cargo from discharge points to ammunition storage areas. In this case, a detailed paper copy list of container contents could be affixed to the interior or exterior of the container for the use of ammunition personnel in warehousing and other supply management functions at the storage location.

The major point is that in the midrange time period, container control measures will be (or can be) in existence, either manual or automated or a combination, that will facilitate the handling, movement, and storage of containerized ammunition.

C. MATERIALS HANDLING EQUIPMENT

1. Straddle Carriers

High-mobility straddle lift devices are currently in the Marine Corps exploratory development program. For example, Standard Manufacturing Company, Inc., has proposed (but not adequately tested) a wishbone container transport system, illustrated in Figure VI-6 picking up and transporting an 8'x8'x20' (or 8.5'x8'x20') container to the beach. It could have a payload capacity is 50-60,000 pounds; its maximum speed is 45 mph unloaded or 25 mph with full load. The wishbone carrier has a unique "trailing arm drive" undercarriage that provides excellent rough-terrain mobility as well as having the essential characteristics required of highway vehicles. According to the manufacturer, the design of the suspension system is such that excessive rutting will not occur from multiple passes

along the same track on unimproved surfaces. In this regard, the wishbone carrier is more than a transport vehicle. It can load and unload container haulers (e.g., MK14) and stack containers two-high on the ground, i.e., perform all necessary tasks required of a container handler in a CSSA ammunition storage/issue complex. This item is in the early stages of the development process and therefore its potential with regard to efficiency and productivity has not been determined.

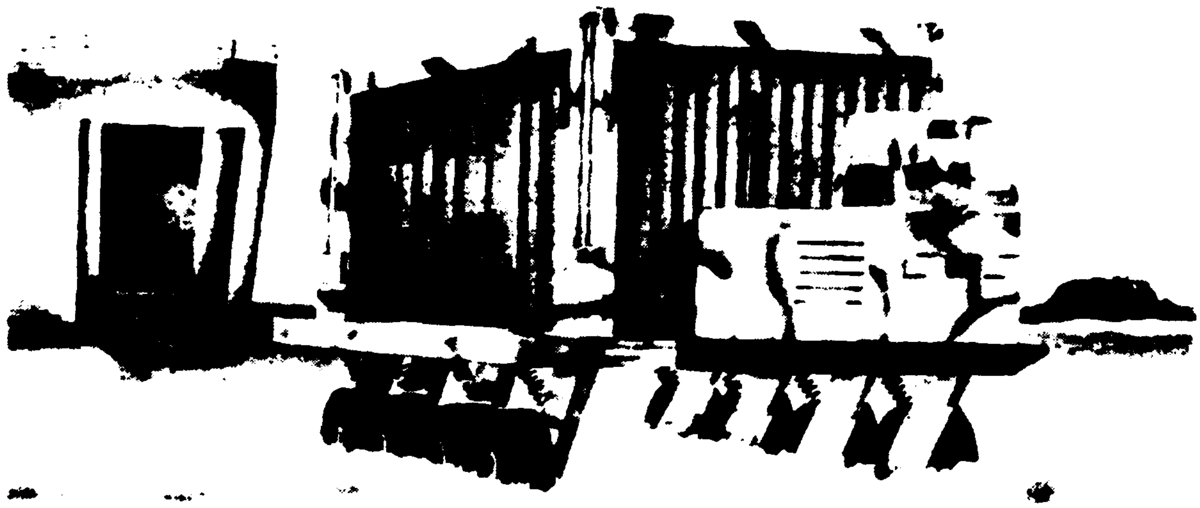
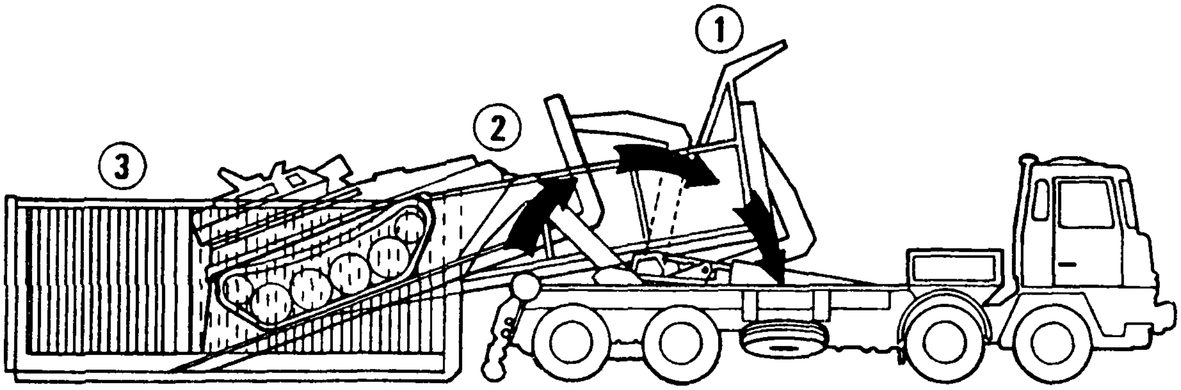


FIGURE VI-6.
WISHBONE CONTAINER TRANSPORT SYSTEM

The NCEL report [Ref 11], as noted in the discussion relative to the RTCH in Chapter V, recommended that a marginal terrain straddle lift container handler (or simply straddle carrier) be selected as the container handler in a CSSA. Such straddle carriers can be either wheeled (as in the case of the wishbone container handler) or tracked. It would appear that the wheeled type (with high flotation tires) would be preferred due to less wear and tear on working surfaces, a greater speed capability, and less maintenance requirements.

2. Self-Loading/Unloading

This term refers to a concept for a container transporter that can load and offload the containers without additional MHE. For example, the UK (Hearncrest Boughton Engineering, Ltd.) has developed the Demountable Rack Offloading and Pickup System (DROPS), which uses a hydraulically operated arm and roller system to pick up and drop containers of other loads (Figure VI-7). This illustration shows three possible types of loads that can be handled this way. The hydraulic arm also can be used as a crane. Depending on the size and type of the truck chassis, which could be any commercial or military model, payloads could vary from 6 to 40 tons.



PRIME MOVER CAPABLE OF HYDRAULICALLY LOADING OR UNLOADING
① TRUCK BED
② VEHICLE ON PLATFORM
③ ISO CONTAINER OR FLAT RACK

FIGURE VI-7.
DEMOUNTABLE RACK OFFLOADING AND PICKUP SYSTEM

The Army has adapted the DROPS concept into the palletized load system (PLS), which has been evaluated at Fort Lewis by the 9th Infantry Division and was recently demonstrated at Fort Eustis as part of PROLOG 84, which was a display of current and future Army combat service support hardware developments. The PLS includes a companion trailer, which is also loaded

and unloaded by the hydraulic arm; the total payload of the truck and trailer combination for the initially fielded system will be 30 tons, or 15 tons each. The U.S. Army Transportation School estimates that this payload (which is governed by the design of the flat rack) is sufficient for most classes of supply, including many ammunition items. (However, far-term concepts being developed by the U.S. Army Missile and Munitions Center and School (MMCS) for ammunition supply and distribution envision the PLS such that each pallet-mounted ISO container will hold a "magazine insert" designed for bare rounds and other munitions items with minimal packaging; the payload of such a container will be on the order of 20 tons, for a 40 ton total for the truck-trailer system.) The operational capability date for the initial PLS is scheduled to be about FY 87.

A self-loading container hauler could be especially useful in an AOA in the role of transporting ISO containers or flat racks to and from Class V(W) field ammunition dumps or any location where container handling equipment is not available.

3. Shooting Boom Forklift Truck

Figure VI-8 illustrates the principle of operation of the shooting-boom forklift truck, which provides great flexibility for container unstuffing. Its primary advantage over the 4K RTFL is that the machine does not have to enter the container to extract the contents. Also, the shooting boom can perform equally well whether the container is on the ground, on an elevated platform, or on a chassis. The boom can swing as much as 50 degrees to either side; thus, the machine can extract a load from a container and place it on the ground without moving from its spot. Under optimum conditions, average cycle time for picking up a load, extracting it, and putting it down has been observed to be about 1 minute (therefore, 12 minutes for a container with 12 pallets in it, or 4.7 containers per hour assuming 1 minute travel time from one container to another). A more conservative (and realistic) estimate would give the shooting-boom forklift truck about a two-to-one or three-to-one advantage

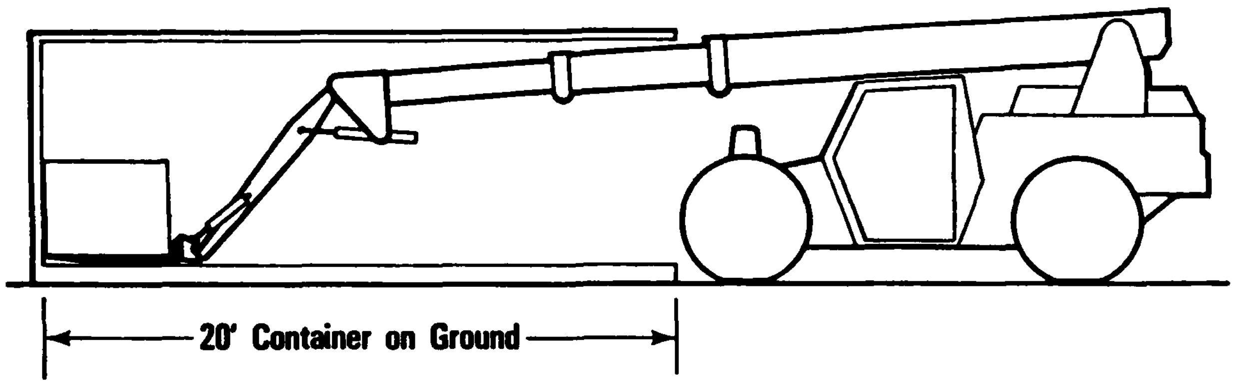


FIGURE VI-8.
SHOOTING BOOM FORKLIFT TRUCK

These machines are available commercially and, depending on the size desired, can be procured relatively quickly. The Army has decided to replace its current fleet of aging 6K RTFLs with the same capacity machine with a boom that can be extended to 30 feet; the current schedule is to award a contract in September 1984 and begin accepting delivery of the 6K shooting boom forklifts in July 1986. The Marine Corps is staffing a ROC for a 15K "extensible boom" forklift and, with advanced development to begin shortly, projects an initial operational capability (IOC) in FY 87.

Should the Marine Corps decide to join the Army in replacing its 6K RTFLs with the shooting-boom version, it will have a superb capability with both 6K and 15K machines for efficiently handling various palletized/containerized ammunition loads in an AOA.

4. Slip Sheet Ammunition Handling System

The slip sheet can be used to extract an entire load of ammunition, weighing up to 20 tons, from cargo containers as a unit load, thereby allowing easy access to the palletized loads by MHE. The slip sheet system consists of a polyethylene sheet, which is placed on the floor of the cargo container prior to ammunition being stuffed, and a clamping device that is used to extract the sheet with its load from the container. Various

consists of a polyethylene sheet, which is placed on the floor of the cargo container prior to ammunition being stuffed, and a clamping device that is used to extract the sheet with its load from the container. Various methods can be used to extract the container contents; the truck winch-to-trailer technique in Figure VI-9 is shown for illustrative purposes only. In an AOA, loads would most likely be extracted directly onto the ground by drawing out the slip sheet by whatever means are available.

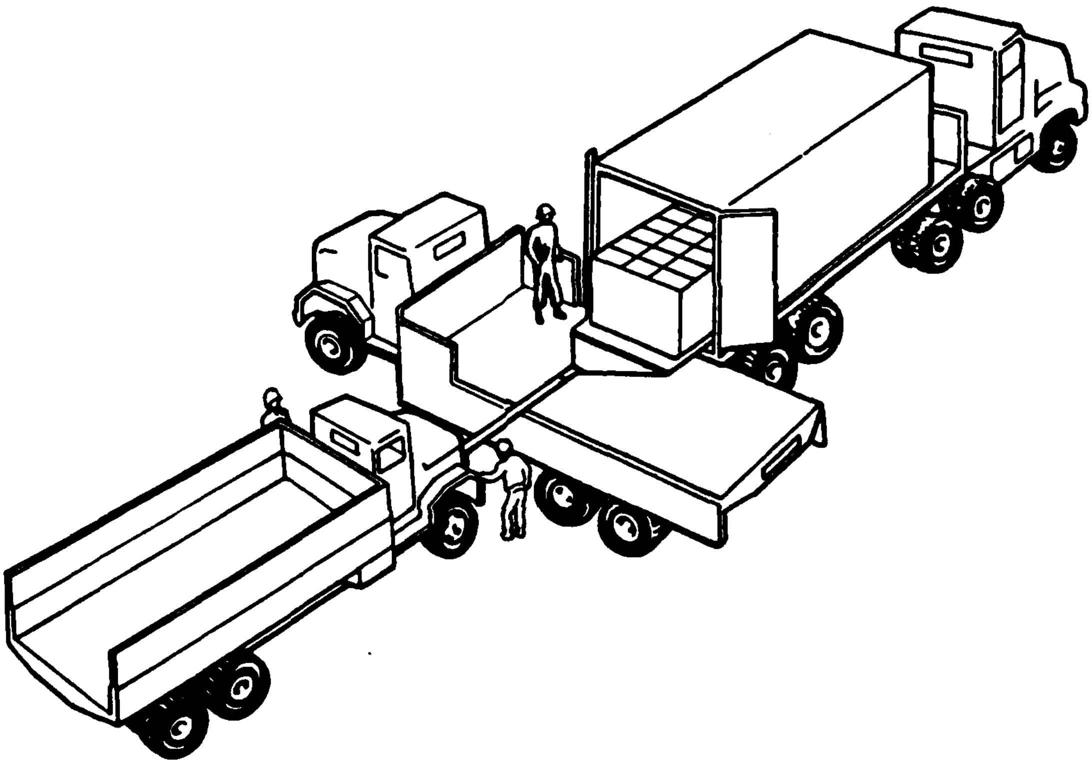


FIGURE VI-9.
SLIP SHEET AMMUNITION HANDLING SYSTEM

Using this technique for extracting container loads could eliminate reliance on the 4K RTFL as the only means for unstuffing containers and could better than double the productivity cited earlier for the 4K RTFL for container unstuffing. Slip sheets currently are undergoing engineering tests at the Belvoir R&D Center and the DACS; the next step would be

military potential tests in CONUS and OCONUS. However, a projected IOC date for the routine use of slip sheets in ammunition containers is not available at this time.

D. SUMMATION

The foregoing discussion has briefly highlighted selected existing or developmental items that can play a key role in the receipt, handling, movement, and storage of containerized ammunition in an AOA.

1. Containers

- Flat Racks
  - -- Open flat rack containers merit serious consideration for the intertheater and intratheater shipment of containerized ammunition.
  - -- The extensive testing and other data on flat racks gathered by the Air Force provide an opportunity to speed up Marine Corps evaluation of their applicability to the support of MAGTFs in an AOA.
- British Unit Load Container
  - -- The ULC concept of standardizing exterior container size and tailoring ammunition loads to fit interior space seems to be ideally suited to the support and operations of MAGTFs, particularly in more efficient retail resupply activities within an AOA.
  - -- The operational experience and manufacturing expertise assembled by the UK provide a ready source of information on how the ULC might be applied, or modified, to be suitable for Marine Corps use.
- U.S. Army Packaging Initiatives
  - -- Current Army programs to reduce the weight and cube of ammunition packaging/containerization will provide for more efficiency in the handling, movement, and storage of ammunition at both the wholesale and retail level.
  - -- These initiatives will begin to be implemented in the midrange time frame, but the outlook in this period for most items is that the Marine Corps will still be dealing with wholesale ammunition packaging and palletized unit loads as currently configured.

- Container Identification and Control

  -- Technologies and techniques exist that will permit the implementation of container identification and control measures commensurate with the requirements for traffic and supply inventory management of containerized ammunition.

2. Materials Handling Equipment

- Straddle Carriers

  -- Straddle carriers could perform a variety of tasks in an AOA that currently require different pieces of equipment (shown in parentheses) vis: offloading containers from beached landing craft (LACH); transporting ISO containers on the highway or cross-country (MK48/MK14); and offloading, handling, and transporting containers in marshaling yards and storage areas (RTCH).

  -- Use of a straddle carrier would permit much more efficient storage (side-by-side pattern with less space between containers) in containerized ammunition storage areas.

- Self-Loading Container Haulers

  -- Use of the self-loading container haulers permit loading, offloading, and movement of large ammunition containers to and from any location in the AOA without requiring specialized container lifting and handling equipment.

- Shooting-boom Forklift

  -- The shooting-boom forklift provides a capability for unstuffing enclosed containers that is superior by far to any other known machine designed to do the same thing.

  -- Apart from unstuffing containers, the unique design of the shooting boom forklift should also give it an edge in productivity in any task now being performed by conventional RTFLs.

- Slip Sheet Ammunition Handling System

  -- Use of slip sheets in ammunition containers would provide flexibility in the use of expedient means to unstuff the containers in an AOA, but when slip sheets will be routinely used for this purpose is indeterminate at this time.

VII. CONCEPT DEVELOPMENT ANALYSIS

A. NARROWING THE ALTERNATIVES

The objective of this chapter is to provide an analytic basis for the development of a concept for handling containerized ammunition using FLS equipments. Concepts utilizing other items of equipment discussed in the previous chapter are not explored.

The concept for handling containerized ammunition must be compatible both with Marine Corps methods for handling palletized ammunition and with Marine Corps methods for handling other classes of supply. Methods for handling palletized ammunition are well established as are general concepts for operating at the beach and in the Combat Service Support Area (CSSA). The Marine Corps has yet to establish a doctrine for controlling and handling ISO containers.

The resupply network for breakbulk ammunition (Figure VII-1) has the following successive nodes:

- Beach Transfer Point (BTP) - the point where materiel is deliverd to the beach.
- Beach Support Area (BSA) - an area at or near the beach for directing and expediting the movement of materiel inland.
- Ammunition Supply Point (ASP) - a site where ammunition is stored and controlled for further distribution to using units or munition dumps.
- Munition dump - an assembly, storage, and distribution site between using units and ASPs.
- Using units - the aviation or ground units that consume munitions and require resupply.

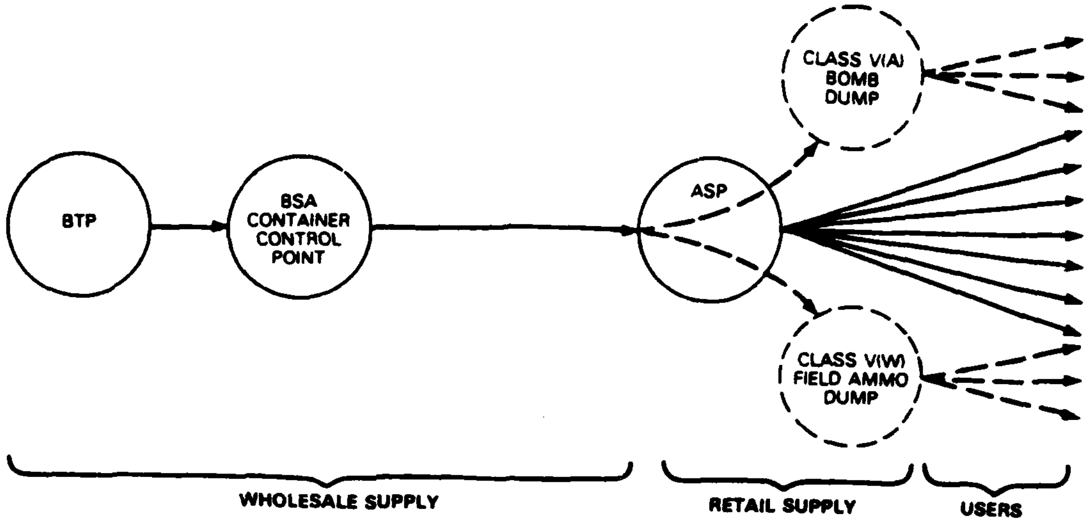


FIGURE VII-1.
CONCEPTUAL AMMUNITION NETWORK

Although the Marine Corps has yet to develop a doctrine for handling containers, the U.S. Army has published FM 54-11, Container Movement and Handling in the Theater of Operations. This document calls for a centralized management and control activity to track the status and location of all container assets in the theater. FM 54-11 stresses a policy that encourages the use of containers for transportation but discourages their use for storage. Containers should be used to expedite shipment inland, but once a container reaches its destination, it should be unstuffed as soon as possible and returned to the transportation system for reuse. FM 54-11 reflects DoD policy which is also applicable to the Marine Corps.

Ammunition will be delivered to the BTP in both breakbulk form and in ISO containers. Breakbulk ammunition is on metal or wooden pallets; ammunition in containers is also on pallets. Whether delivered to the beach in breakbulk or containers, ammunition will be delivered to using units on pallets.

The major remaining issues are how far forward in the ammunition resupply network ISO containers should be carried and how much equipment is required. The alternative locations for terminating the flow of containers are:

- The beach
- ASPs
- Forward ammunition or bomb dumps
- Using units.

The following sections address the question of which of these locations is best for unstuffing containers in order to meet required ammunition resupply rates, while minimizing requirements for FLS equipment items. The approach uses the adjusted daily production estimates for typical operations described in Appendix E to develop a requirement factor for each item of equipment at each node as applicable to each unstuffing alternative. The requirement factor is the equipment requirement per CEU of required throughput per day and does not include allowances for lack of availability due to mechanical failure or hostile action.

B. BEACH VERSUS ASP UNSTUFFING

Considerable amounts of space and equipment are required for unstuffing large numbers of ammunition containers and issuing the contents in breakbulk form. Since space is at a premium in the vicinity of the BTP, it is probably not practical to conduct unstuffing operations at the beach. The following example uses the equipment productivity factors presented in Appendix E to illustrate that less equipment is required to unstuff at an ASP than at the beach.

Consider a steady state case where all ammunition is issued to using units in breakbulk form from a single ASP located D miles inland from the beach. Further, assume X cpd of containerized ammunition are delivered to the beach in ISO containers in landing craft and, as these containers are offloaded, an equal number of empty containers must be loaded back on the landing craft for retrograde.

LACH Requirements

For the case where containers are unstuffed at the beach, the LACH would be used to transfer containers between landing craft and a point on the beach where a RTCH could move them to and from the unstuffing site. If

containers are unstuffed at an ASP, then the LACH would be used to transfer containers between landing craft and transporters. These are comparable tasks for the LACH. A reasonable productivity factor for the LACH (Appendix E) is 120 such transfers per day. If the requirement is to bring in X cpd and retrograde X cpd, then the required number of LACHs is 2X/120 or .017X. Thus, the requirement factor for the LACH is .017.

RTCH Requirements

For the beach unstuffing case where containers are delivered to the beach in landing craft, the RTCH would be required to move containers from the point where they are dropped on the beach by a LACH to a temporary storage location, then to an unstuffing location, then to a temporary storage location for empty containers, and finally back to a location where a LACH can pick them up for retrograde. These same steps would be required at the ASP for the ASP unstuffing case, except the cycle would begin and end with containers on a transporter instead of on the ground. Assuming similar typical layouts at each location, RTCH requirements can be calculated as shown in Table VII-1.

TABLE VII-1. RTCH REQUIREMENTS FOR COMMON OPERATIONS

	RTCH Productivity	Requirement Factor
Move full container to storage	91 cpd	.011
Retrieve full containers from storage for unstuffing	91 cpd	.011
Move empty container to storage	103 cpd	.010
Retrieve empty container from storage for retrograde	103 cpd	.010
		.042

4K RTFL Requirements

For beach unstuffing, 4K RTFLs are required both at the beach and at the ASP. If containers are unstuffed at the ASP, however, 4K RTFLs are required only at the ASP. Forklift requirements for these two cases are shown in Table VII-2.

TABLE VII-2. COMPARISON OF 4K ROUGH TERRAIN FORKLIFT REQUIREMENTS FOR BEACH AND ASP UNSTUFFING

	4K RTFL Productivity	Requirement Factor
Beach Unstuffing		
At the beach:		
Unstuff containers	23 cpd	.043
Move pallets to loading point	15 cpd	.067
Load trucks	26 cpd	.038
		.148
At the ASP:		
Offload trucks	26 cpd	.038
Move pallets to storage	15 cpd	.067
Retrieve pallets from storage	15 cpd	.067
Load trucks	26 cpd	.038
		.210

ASP Unstuffing

	4K RTFL Productivity	Requirement Factor
Unstuff containers	23 cpd	.043
Move pallets to storage	15 cpd	.067
Retrieve pallets from storage	15 cpd	.067
Load trucks	26 cpd	.038
		.215

MK48/MK14 Requirements

Transporter requirements depend on the travel time between the ASP and the dump as well as the required throughput of ammunition. Table E-2 (Appendix E) shows unit productivity factors (CEUs per day) for one way travel times ranging from 5 to 60 minutes. Table VII-3 shows the corresponding MK48/MK14 requirement factors.

TABLE VII-3. MK48/MK14 REQUIREMENT FACTORS

One-Way Travel Time (minutes)	Container Shipping	Palletized Loading With One 4K RTFL	Palletized Loading With Two 4K RTFLs
5	0.048	0.127	0.069
10	0.061	0.138	0.081
15	0.073	0.150	0.092
20	0.086	0.161	0.104
25	0.099	0.173	0.115
30	0.111	0.184	0.127
35	0.124	0.196	0.138
40	0.137	0.207	0.150
45	0.149	0.219	0.161
50	0.162	0.230	0.173
55	0.175	0.242	0.184
60	0.187	0.253	0.196

Consider an example where the distance from the BTP to the ASP is 2.5 miles and the MK48/MK14 can average 15 MPH, then the one-way travel time is 10 minutes. A throughput of 100 CEUs per day would require:

6.1 MK48/MK14s if ammunition were shipped in containers

13.8 MK48/MK14s if ammunition were shipped on pallets using one 4K RTFL at a time for loading and offloading

8.1 MK48/MK14s if ammunition were shipped on pallets using two 4K RTFLs at a time for loading and offloading

Summary Example

Table VII-4 shows a comparison of equipment requirements for a steady-state throughput of 100 cpd through a single ASP.

TABLE VII-4. EQUIPMENT REQUIREMENTS COMPARISON

	Beach Unstuffing	ASP Unstuffing
LACH	1.7	1.7
RTCH	4.2	4.2
4K RTFL	35.8	21.5
MK48/MK14 (10 min travel time)	8.1	6.1

This comparison indicates substantial equipment savings in 4K RTFL and MK48/MK14 requirements for unstuffing containers at the ASP instead of the beach. This assumes LACHs are required to handle containers at the beach. If some or all of the containers come ashore on transporters over an ELCAS, then the efficiency argument for unstuffing at the ASP is even stronger, since offloading the transporter on the beach to unstuff and reload its contents on a transporter for shipment to the ASP just adds another step to the process.

C. ASP VERSUS MUNITION DUMP UNSTUFFING (CONTAINERS GROUNDED AT ASP)

A munition dump could be a bomb dump located at or near an airfield or a field ammunition dump for Class V(W). Munitions could be delivered to the dump in containers or on pallets, but would be issued to using units in breakbulk form. Containers could be shipped directly from the BTP to the dump as examined in the next section. The analysis in this section addresses equipment requirements to deliver breakbulk ammunition at the dump, assuming that full and and empty containers are grounded and stored at the ASP en route to and from the munition dump. Since equipment requirements are proportional to the required throughput of the dump, the following analysis expresses the requirements as a factor. This requirement factor multiplied by the CEUs of throughput at the dump (and rounded to the next higher integer) gives the required number of equipment items.

RTCH Requirements

For ASP unstuffing, the RTCH is required only at the ASP. The requirements at the ASP are the same as those shown in Table VII-1.

For dump unstuffing, however, the RTCH is required at both the ASP and the dump. These requirements are shown in Table VII-5.

TABLE VII-5. RTCH REQUIREMENTS FOR DUMP UNSTUFFING

At the ASP:

	RTCH Productivity	Requirement Factor
Offload and store full containers	91 cpd	.011
Retrieve full container from storage and load transporter	91 cpd	.011
Offload empty container from transporter to storage	103 cpd	.010
Retrieve empty containers from storage and load transporter	103 cpd	.010
		.042

At the dump:

	RTCH Productivity	Requirement Factor
Offload and store full containers	91 cpd	.011
Retrieve full containers from storage for unstuffing	91 cpd	.011
Move empty containers to storage	103 cpd	.010
Retrieve empty containers from storage and load transporter	103 cpd	.010
		.042

4K RTFL Requirements

If containers are unstuffed at the ASP, then 4K RTFLs are required at both locations and the minimum forklift requirements occur when containers are used for storage at the ASP and are unloaded only as ammunition trucks arrive to carry their contents forward. In Table VII-6, 4K RTFL requirements for this case are compared to the case where containers are transported to the dump. In the latter case, 4K RTFLs are not required at the ASP for ammunition that is shipped to the dump in containers.

TABLE VII-6. COMPARISON OF 4K ROUGH TERRAIN FORKLIFT REQUIREMENTS FOR ASP AND DUMP UNSTUFFING

ASP Unstuffing

	4K RTFL Productivity	Requirement Factor
At the ASP:		
Unstuff containers	23 cpd	.043
Move pallets to loading site	15 cpd	.067
Load trucks	16 cpd	.038
		.148
At the dump:		
Offload trucks	26 cpd	.038
Move pallets to storage	15 cpd	.067
Retrieve pallets from storage	15 cpd	.067
Load trucks	26 cpd	.038
		.210

Dump Unstuffing

	4K RTFL Productivity	Requirement Factor
Unstuff containers	23 cpd	.043
Move pallets to storage	15 cpd	.067
Retrieve pallets from storage	15 cpd	.067
Load trucks	26 cpd	.038
		.215

MK48/MK14 Requirements

Transporter requirements depend on the travel time between the ASP and the dump as well as the required throughput of ammunition. Table VII-7 shows factors for one-way travel times ranging from 5 to 60 minutes.

TABLE VII-7. MK48/MK14 REQUIREMENT FACTORS

One-Way Travel Time (minutes)	Container Shipping	Palletized Loading With One 4K RTFL	Palletized Loading With Two 4K RTFLs
5	0.048	0.127	0.069
10	0.061	0.138	0.081
15	0.073	0.150	0.092
20	0.086	0.161	0.104
25	0.099	0.173	0.115
30	0.111	0.184	0.127
35	0.124	0.196	0.138
40	0.137	0.207	0.150
45	0.149	0.219	0.161
50	0.162	0.230	0.173
55	0.175	0.242	0.184
60	0.187	0.253	0.196

Summary and Rounding Considerations

The equipment requirement factors for each CEU of throughput per day, at each location are given in Table VII-8.

Table VII-8 shows that compared to the two 4K RTFL loading case for ASP unstuffing, the dump unstuffing alternative offers savings in 4K RTFL and MK48/MK14 requirements at the expense of additional requirements for RTCH services at the dump. For each CEU/day of required throughput at the dump, the penalty is .042 additional RTCHs (at the dump), and the savings are .143 fewer RTFLs (at the ASP) and .01 to .02 fewer MK48/MK14s depending on travel times.

For continuous operations, it is probably not practical to move MHE between ASPs and munition dumps. Thus, requirements for RTCHs or 4K RTFLs must be treated as integers at each node. Similarly, fractional changes in numbers of MK48/MK14s required may have no practical meaning. The throughput at the dump would have to exceed 50 to 100 CEUs per day to save a whole MK48/MK14. The integer changes in MHE requirements for dump unstuffing are given in Table VII-9.

TABLE VII-8. REQUIREMENT FACTORS FOR ASP VERSUS DUMP UNSTUFFING

Equipment	ASP Unstuffing: One 4K RTFL Loading	ASP Unstuffing: Two 4K RTFL Loading	Dump Unstuffing
RTCH			
ASP	.042	.042	.042
Dump	-	-	.042
	.042	.042	.084
4K RTFL			
ASP	.148	.148	-
Dump	.210	.210	.215
	.358	.358	.215
MK48/MK14			
(depending on travel time)			
5 min	.127	.069	.048
10 min	.138	.081	.061
20 min	.161	.104	.086
40 min	.207	.150	.137
60 min	.253	.196	.187

TABLE VII-9. EFFECT OF DUMP UNSTUFFING ON EQUIPMENT REQUIREMENTS

Dump Throughput (CEUs per day)	Additional RTCHs	4K RTFLs Saved
0 - 7	1	0
7 - 14	1	1
14 - 21	1	2
21 - 24	1	3
24 - 28	2	3
28	2	4
35	2	5
42	2	6
48	3	7
56	3	8

The procurement cost of a RTCH is about 6 times that of a 4K RTFL. But since life cycle costs are largely people costs, the study team believes the life cycle cost of the RTCH is less than twice that of the 4K RTFL. Since a RTCH costs more than a 4K RTFL, dump unstuffing does not pay for throughputs less than about 14 CEUs per day. If a trade of two 4K RTFLs for one RTCH is favorable, dump unstuffing pays for dump throughputs in excess of 28 CEUs per day. Dump unstuffing might pay for dump throughputs of 14-24 CEUs per day but this runs the risk of operating a dump with one RTCH--if the RTCH is damaged or breaks down, then all container handling capabilities would be lost and a costly bottleneck in operations could result. Thus, the foregoing analysis suggests the use of dump unstuffing for expected dump throughputs in excess of about 28 containers per day. As a reasonable rule of thumb, this threshold value is rounded to 30 cpd.

D. DIRECT SHIPMENT OF CONTAINERS TO DUMPS (CONTAINERS NOT GROUNDED AT ASP)

The previous section assumed that ammunition containers were grounded and stored at an ASP en route to and from the ammunition dump. This section addresses the MHE savings that could be realized if handling the ammunition at the ASP could be avoided by directing container haulers coming from the BTP to proceed directly to the dump. Also, haulers returning with empty containers from the dump would proceed directly to the BTP.

RTCH Requirements

For ASP unstuffing, the requirement is .042 RTCH per CEU of throughput as previously derived in Table VII-1. For direct shipping, there is no requirement at the ASP and the requirements at the dump are .042 RTCHs per CEU per day to perform the same tasks that would otherwise be performed at the ASP.

4K RTFL Requirements

The analysis of 4K RTFL requirements is the same as that in the previous section (Table VII-2). These requirement factors show an expected savings of about .15 forklifts per CEU of required throughput if unstuffing is conducted at the dump instead of the ASP.

Rounding Considerations

If the throughput at the dump is an even multiple of the daily capacity of the RTCH (about 24 cpd), then no additional RTCHs are required to perform the container handling operations at the dump instead of the ASP--the additional requirements at the dump are offset by a reduced requirement at the ASP. If the requirement at the dump is not an even multiple of the daily RTCH capacity, then one additional RTCH is required. Table VII-10 shows the integer changes in MHE for using direct shipping to the dump instead of ASP unstuffing, assuming a $\pm$10% window for defining an even multiple.

TABLE VII-10. EFFECTS OF THROUGHPUT TO DUMP ON MHE

Dump Throughput	Additional RTCHs	4K RTFLs Saved
0 - 7	1	0
7 - 14	1	1
14 - 22	1	2
21 - 26	0	3
26 - 28	1	3
28 - 35	1	4

If two-for-one is a favorable trade of 4K RFTLs for RTCHs, then direct shipping and unstuffing at the dump has payoff whenever the required throughput of the dump exceeds about 14 CEUs per day. Again, however, if the throughput at the dump is less than about 24 CEUs per day, then only one RTCH would be required at the dump and the dump would run the same risks of operating with a single RTCH as discussed in the previous section.

E. SHIPPING CONTAINERIZED AMMUNITION TO USERS

For purposes of this analysis, the question concerning whether ammunition should be shipped to using units in containerized or breakbulk form is exactly the same as the question as to whether containers should be shipped to munition dumps. In terms of MHE and transport requirements, having containerized ammunition delivered to a unit is the same as having containerized ammunition delivered to a munition dump co-located with the unit. Thus, shipping containerized ammunition to a unit would have payoff if the unit consumed more than about 30 CEUs per day, or if the unit consumed more than about 14 CEUs per day and were close enough to another unit with RTCH assets so that the risk of operating with one RTCH were not too great.

F. QUALFICATIONS

The foregoing analysis establishes some rules of thumb that form the basis for the concept presented in the next chapter. The analysis assumes that user requirements for ammunition must be met, that these ammunition requirements are to be met with a concept that employs only current FLS equipments, and that the objective is to minimize the quantitative requirements for the FLS equipment items to provide the required ammunition supply rate to the using units. The rules of thumb do not consider scenario dependent factors such as mission, terrain, enemy forces, and immediately available quantities of operational equipment that would cause a commander to do things differently in a particular tactical situation.

VIII. THE CONCEPT AND ITS APPLICATION

This chapter defines a recommended concept for handling containerized ammunition in an AOA and examines its applications to a typical MAF scenario for:

- AFOE offloading
- Steady state resupply at sustaining rates
- Steady state resupply at intense rates

A. CONCEPT DEFINITION

The concept is a description of the equipment and procedures for the movement of containerized ammunition from its arrival at the BTP through the issue of the container contents in breakbulk form at a retail supply point, and includes the retrograde of empty containers. A retail supply point is an ASP, a Class V(A) bomb dump, or a Class V(W) field ammunition dump. Wholesale nodes in the resupply network are the BTP and a container control point in the beach support area (see Figure VIII-1).

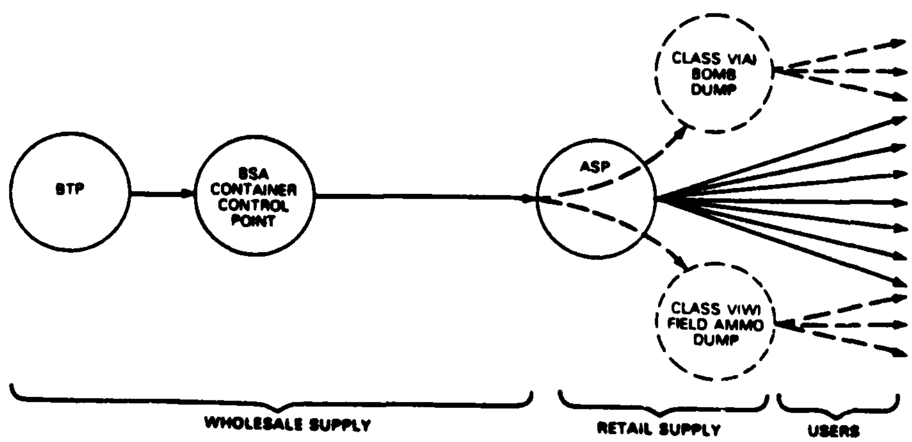


FIGURE VIII-1.
CONCEPTUAL AMMUNITION NETWORK

At least one BTP and one ASP will be established in the AOA prior to AFOE offloading. For subsequent resupply operation, an AOA could have more than one BTP and more than one ASP. Bomb dumps or field ammunition dumps may be established whenever it is convenient to do so under current doctrine for handling breakbulk ammunition, but these dumps are not necessarily configured to handle containerized ammunition.

The concept can be fully implemented using FLS equipments:

- The MK48/MK14 is used to transport containerized ammunition forward and retrograde empty containers.
- The LACH is used to load/offload the MK48/MK14 at the BTP (LACHs may not be required if port facilities or an ELCAS are available).
- The RTCH is used to handle containers at ASPs and dumps configured to handle containerized ammunition; container handling tasks include loading or offloading containers from the MK48/MK14 and moving containers to and from storage and unstuffing sites.
- The 4K RTFL is used to unstuff containers and handle breakbulk ammunition; breakbulk handling tasks include moving palletized ammunition to and from storage and loading it onto trucks.

Incoming containers will be loaded on MK48/MK14 transporters at the BTP by LACHs or shipboard cranes and cleared from the BTP as rapidly as possible. The flow of all containers and transporters to and from the BTP will be centrally managed by an element of the CSSE responsible for tracking the status and location of all containers in the AOA. This central container control element will operate a control point in the vicinity of the BTP and direct all ammunition containers to an ASP.

Figure VIII-2 illustrates a conceptual layout for an ASP capable of handling both containerized and breakbulk ammunition. This layout features a container control point for recording and directing the flow of all container traffic to and from the ASP. Transporters with full containers coming from the BTP can be directed to the container offloading site at the ASP or sent directly to a bomb or ammunition dump. Similarly, a transporter returning from a dump with an empty container can be directed to the retrograde storage area at the ASP or sent directly to the BTP. This container control point will assist the CSSE central container control element in tracking containers and controlling their flow to the BTP for retrograde.

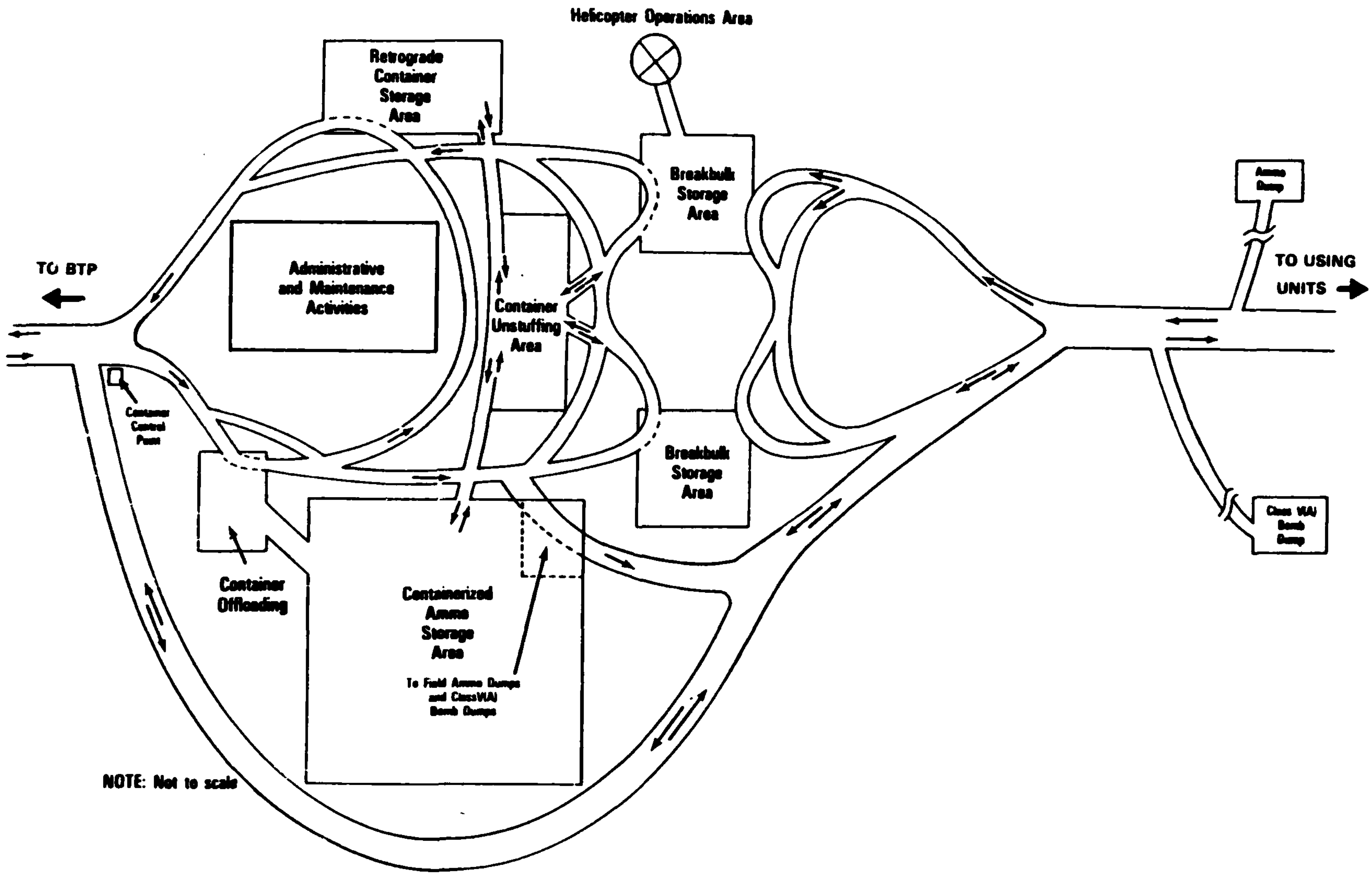


FIGURE VIII-2.
CONTAINERIZED AMMUNITION ASP COMPLEX

If bomb or ammunition dumps are established to receive containerized ammunition, then transporters arriving at the ASP from the BTP will be sent directly to those dumps, whenever possible, to avoid unnecessary handling of the container at the ASP. Otherwise, incoming full containers are off-loaded for temporary storage until they can be unstuffed or reloaded on transporters for shipment to a bomb or ammunition dump. In accordance with DoD policy, use of containers for storage will be avoided. Thus, unless full containers are identified for shipment elsewhere, they will unstuffed as rapidly as practical and their contents placed in breakbulk storage.

Whenever possible, bomb dumps and field ammunition dumps will be configured to handle containerized ammunition if their expected throughput is 30 container loads or more per day. These large dumps will require at least two RTCHs for container handling tasks. Dumps with expected throughputs of less than about 15 CEUs per day are too small to make efficient use of a RTCH and should not be configured for container handling. Dumps with expected throughputs of 15 to 30 CEUs per day may be configured to handle containers and equipped with one RTCH if the risks of losing the RTCH are judged acceptable. Dumps configured to handle containers should have a layout similar to the ASP layout shown in Figure VIII-2.

B. CONCEPT REQUIREMENTS FOR AFOE OFFLOADING

The AFOE is planned to come ashore over a 25-day period beginning at about D+5. By D+5, CSS elements of the assault echelon will have already established at least one ASP. The AFOE will bring with it about a 45-day supply of ammunition, including ammunition delivered from Maritime Preposition Ships (MPS). The 45-day supply (15 days at intense rates and 30 days at sustaining rates) corresponds to about 6300 CEUs. If all of this were delivered in containers over a 25 day period, then the average off-loading rate would be 252 CEUs per day. MPS-2 has 1415 ammunition containers which are to be offloaded at the beach in 5 days--an average of 288 cpd. Thus, AFOE requirements for moving containers from the BTP to an ASP would average about 250 CEUs per day surging to as high as 288 cpd. At the

same time, the ASP would be required to unstuff containers and issue breakbulk ammunition to using units. This issue rate could vary from sustaining rates (118 cpd) to intense rates (185 cpd). Thus, as an upper bound, the analysis in this section provides equipments estimates to receive 288 cpd at the ASP and deliver 185 CEUs per day from the ASP during the AFOE offloading period. The analysis first assumes that all ammunition is containerized then examines a case where all ammunition other than MPS is delivered in breakbulk form.

Not all containers would have to be retrograded during AFOE offloading since some containers would be needed to fill the container pipeline in the AOA for steady-state operations during the resupply phase. In keeping with DoD policy, however, as many as practical should be retrograded. The analysis in this section assumes that the 185 cpd that could be unstuffed at the ASP during the AFOE offloading period are retrograded to landing craft at the BTP.

LACH Requirements

To offload 288 cpd from landing craft to transporters and retrograde 288 cpd back to landing craft requires about 4.8 LACHs, based on the 120 cpd LACH productivity estimate provided in Appendix E for each operation.

RTCH Requirements

RTCH requirements at the ASP are computed using productivity factors developed in the previous chapter. If all ammunition is delivered in containers, then the requirements are as shown in Table VIII-1.

TABLE VIII-1. RTCH REQUIREMENTS, AFOE OFFLOADING

Task	Productivity Factors	Throughput Requirement	RTCH Requirement
Offload transporter and store full container	.011	288	3.17
Move full containers from storage to unstuffing site	.011	185	2.04
Move empty container from unstuffing site to storage	.010	185	1.85
Retrieve empty containers storage and load transporter	.010	185	1.85
			8.91 or 9

If only MPS-2 is delivered in containers, then the RTCH is still required to handle 288 cpd of incoming containers over a 5-day period. But the RTCH would not be required for unstuffing operations during this short period since most deliveries to using units could be made from ammunition arriving at the ASP in breakbulk form. From Table VIII-1 above, the requirement to offload and store 288 cpd is 4 RTCHs (rounded up from 3.17). Note that these four RTCHs would be available for unstuffing and retrograde operations for 20 days of the 25-day AFOE offloading period, providing a combined capacity of about 130 cpd for the operations.

4K RTFL Requirements

If all ammunition is in containers, then all requirements for the 4K RTFL are at the ASP. These requirements are shown in Table VIII-2.

TABLE VIII-2. 4K ROUGH TERRAIN FORKLIFT REQUIREMENTS (ALL AMMUNITION CONTAINERIZED)

	Productivity Factor	Required Rate	4K RTFL Requirement
Unstuff container	.043	288	12.4
Move pallets to storage	.067	288	19.3
Retrieve pallets from storage	.067	185	12.4
Load trucks	.038	185	7.0
			51.1 or 52

If only MPS ammunition (1415 CEUs) is in containers, then there is a requirement to handle about 4860 CEUs of incoming breakbulk ammunition. Assuming this is spread evenly over 20 days, the required capacity is about 243 CEUs per day. The 4K RTFL is required to load this palletized ammunition on trucks at the BTP and offload it and store it at the ASP, while continuing to issue ammunition from the ASP. Unstuffing at the ASP is not required; however, more breakbulk ammunition is arriving at the ASP than is required to meet deliveries. Thus, if only MPS ammunition is containerized, the requirements for the RTFL are as shown in Table VIII-3.

TABLE VIII-3. 4K ROUGH TERRAIN FORKLIFT REQUIREMENTS (MPS-2 AMMUNITION CONTAINERIZED)

At the BTP:	Productivity Factor	Required Rate	4K RTFL Requirement
Retrieve pallets from storage	.067	243	16.3
Load trucks	.038	243	9.2
			25.5 or 26
At ASP:			
Offload trucks	.038	243	9.2
Store ammunition	.067	243	16.3
Retrieve ammunition from storage	.067	185	19.1
Load trucks	.038	185	7.0
			51.6 or 52
Total			78

MK48/MK14 Requirements

Transporter requirements depend on the travel times between the BTP and the ASP. Table VIII-4 gives the MK48/MK14 requirements for containerized shipping and a throughput of 288 cpd.

TABLE VIII-4. MK48/MK14 REQUIREMENTS
(ALL AMMUNITION CONTAINERIZED)

One-Way Travel Time	Productivity Factor	MK48/MK14 Requirement
5	.048	13.8
10	.061	17.6
15	.073	21.0
20	.086	24.8
25	.099	28.5
30	.111	32.0

The requirements above apply for the full 25 days if all ammunition is containerized. If only MPS-2 is containerized, the requirements above apply for 5 days and, for the remaining 20 days there is a required rate of 243 CEUs per day breakbulk shipping. These requirements for the breakbulk shipping are shown in Table VIII-5.

TABLE VIII-5. MK48/MK14 REQUIREMENTS
(MPS-2 AMMUNITION CONTAINERIZED)

One-Way Travel Time	Productivity Factor	MK48/MK14 Requirement
5	.069	16.8
10	.081	19.7
15	.092	22.4
20	.104	25.3
25	.115	27.9
30	.127	30.9

C. SUSTAINED RATE RESUPPLY

The sustained rate resupply requirements for a typical MAF deployment were developed in Chapter IV and are shown again in Table VIII-6.

TABLE VIII-6. MAF SUSTAINED RATE RESUPPLY REQUIREMENTS

	CEUs/day
Class V(W)	
Artillery	23.4
Other	9.6
	33.0
Class V(A)	
Forward Base 1	13.4
Forward Base 2	13.4
Main Base 1	10.7
Main Base 2	10.7
SELF	36.6
	84.8

How much of this ammunition would be delivered to the BTP in containers is uncertain, but 100 percent is a reasonable assumption as an upper limit. The numbers and locations of ASPs and munition dumps in the AOA depends on the geography and the threat. For illustrative purposes, assume two ASPs have been established (one primarily for Class V(W) and one primarily for Class V(A)), that bomb dumps have been established at the SELF and each of the two main bases, that a fourth bomb dump has been established to serve both forward bases, and that a field ammunition dump has been established to serve forward artillery units (see Figure VIII-3). Further, assume that travel distances between nodes are as shown in Table VIII-7.

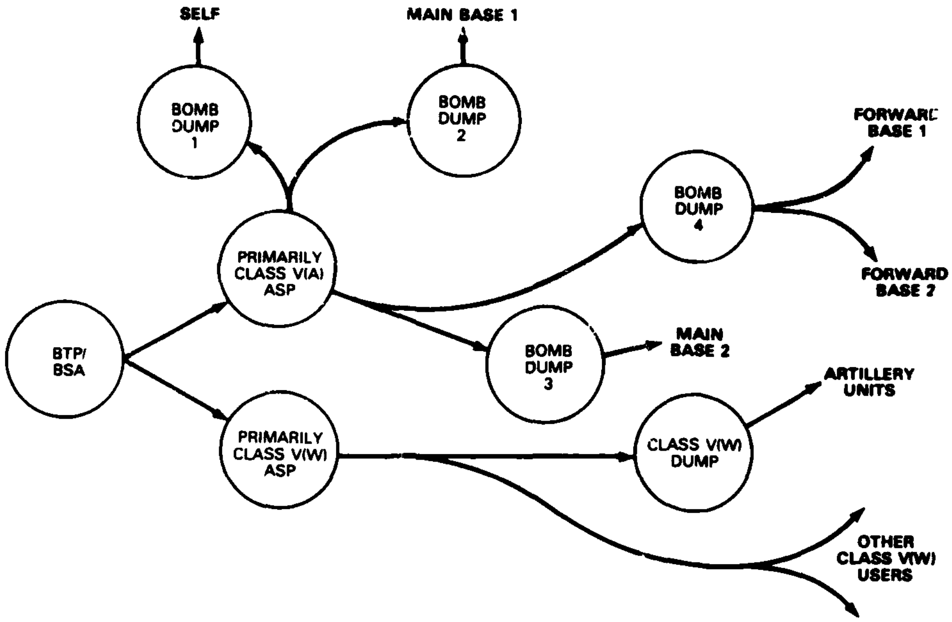


FIGURE VIII-3.
ILLUSTRATIVE AMMUNITION RESUPPLY NETWORK

TABLE VIII-7. ILLUSTRATIVE TRAVEL TIMES

BTP to:	
Class V(W) ASP	10 minutes
Class V(A) ASP	20 minutes
Class V(W) ASP to:	
Class V(W) dump	10 minutes
Class V(A) ASP to:	
Bomb dump 1	10 minutes
Bomb dump 2	20 minutes
Bomb dump 3	20 minutes
Bomb dump 4	40 minutes

The required throughputs at the dumps are given in Table VIII-8.

TABLE VIII-8. ILLUSTRATIVE AMMUNITION THROUGHPUT REQUIREMENTS

	CEUs/day
Class V(W) dump	23.4
Bomb dump 1	36.6
Bomb dump 2	10.7
Bomb dump 3	10.7
Bomb dump 4	26.8

Only bomb dump 1 is large enough to justify configuring it to handle containerized ammunition; all others will handle breakbulk ammunition unstuffed at the ASP. The RTCH requirement at the Class V(A) ASP depends on how many of the containers going to bomb dump 1 can be shipped directly without handling them at the ASP. Depending on this assumption and using the requirement factors developed in Chapter VII, the equipment requirements can be determined and are shown in Table VIII-9.

TABLE VIII-9. ILLUSTRATIVE EQUIPMENT REQUIREMENTS

	LACH	RTCH	4K RTFL	MK48/MK14	
BTP	2	0	0	0	
Class V(W) ASP	0	2	5	2.0	(to and from BTP)
Class V(A) ASP	0	3-5	9	7.3	(to and from BTP)
Class V(W) Dump	0	0	5	3.2	(to and from ASP)
Bomb dump 1	0	2	8	2.2	(to and from ASP)
Bomb dump 2	0	0	3	1.7	(to and from ASP)
Bomb dump 3	0	0	3	1.7	(to and from ASP)
Bomb dump 4	0	0	6	5.5	(to and from ASP)
	2	7-9	39	23.6	

D. INTENSE RATE RESUPPLY

As developed in Chapter IV, the intense rate resupply requirements for a typical MAF deployment are as shown again in Table VIII-10.

TABLE VIII-10. INTENSE RATE AMMUNITION RESUPPLY REQUIREMENTS

Class V(W)	
Artillery	59.4
Other	19.2
	78.6
Class V(A)	
Forward Base 1	16.8
Forward Base 2	16.8
Main Base 1	13.4
Main Base 2	13.4
SELF	45.7
	106.1

Assume that all of the ammunition delivered to the beach to meet these requirements is containerized and that the nodes of the ammunition supply network are the same as used in the previous section to illustrate requirement for sustaining rates. For intense rates, however, the required throughput at the dumps are as shown in Table VIII-11.

TABLE VIII-11. INTENSE RATE AMMUNITION THROUGHPUT REQUIREMENT

	CEUs/day
Class V(W) dump	59.4
Bomb dump 1	45.7
Bomb dump 2	13.4
Bomb dump 3	13.4
Bomb dump 4	33.6

At intense rates, containerized ammunition would be sent to the Class V(W) dump, bomb dump 1, and bomb dump 4--all having throughputs in excess of 30 CEUs/day. The corresponding equipment requirements are given in Table VIII-12.

TABLE VIII-12. INTENSE RATE EQUIPMENT REQUIREMENTS

	LACH	RTCH	4K RTFL	MK48/MK14	
BTP	3.1	0	0	0	
Class V(W) ASP	0	2-4	3	10.8	(to and from BTP)
Class V(A) ASP	0	2-6	4	17.1	(to and from BTP)
Class V(W) dump	0	3	13	3.6	(to and from ASP)
Bomb dump 1	0	2	10	2.8	(to and from ASP)
Bomb dump 2	0	0	3	2.2	(to and from ASP)
Bomb dump 3	0	0	3	2.2	(to and from ASP)
Bomb dump 4	0	2	8	4.6	(to and from ASP)
	3.1	11-15	44	43.3	

E. SUMMARY COMPARISON AND IMPLICATIONS

1. Equipment Requirements Versus Assets

Table VIII-13 compares the requirements for the illustrative examples postulated in previous sections to the planned equipment assets of a MAF (assuming the ASP is 10 minutes from the BTP for AFOE offloading):

TABLE VIII-13. MAF VS ILLUSTRATIVE EXAMPLE EQUIPMENT COMPARISON

	LACH	RTCH	4K RTFL	MK48/MK14
Available Assets				
MAF	12	6	116	145
MPS	4	10	24	20
	16	16	149	165
Potential Requirements (Ammunition Only)				
AFOE offloading	4.8	9	52	17
Sustaining Rate Resupply	2.0	7-9	39	24
Intense Rate Resupply	3.1	11-15	44	44

2. Implications of Assumptions

Readers should be reminded that the potential requirements shown above are only for ammunition and only for a specific set of assumptions

concerning the numbers of nodes in the ammunition resupply network and the travel times between these nodes. Further, the requirement assumes:

- All ammunition is delivered to the BTP in containers
- Equipment works 20 hours per day
- No equipment availability is lost to mechanical failures or hostile action.

Changes in the configuration of the transportation network would have the greatest effect on requirements for the MK48/MK14--longer travel distances would require more transporters. If additional nodes were to handle containerized ammunition, then requirements for the RTCH would increase and requirements for the 4K RTFL and requirements for the MK48/MK14 would decrease.

If only a fraction of the ammunition were delivered to the beach in containers, then requirements for the RTCH would decrease and requirements for the 4K RTFL and the MK48/MK14 would increase.

If equipment were to work less than 20 hours per day, then requirements would increase accordingly--a 10 hour equipment work-day would require more equipment (but perhaps not twice as much) as daylight operations are more productive than night operations. Practically speaking, however, the problem with a 20-hour work day is more with crews than equipments. While a 10-hour workday is a more reasonable assumption for the crew, this would imply a need for more crews and not necessarily a need for more equipment.

Finally, loss of equipment availability to mechanical failures and enemy action will increase equipment requirements--how much depends on assumptions concerning maintenance capabilities and the threat.

3. Organizational Implications

Because the scope of this study is limited to ammunition, it is not possible to justify specific recommendations concerning changes in organization and equipment. However, the analysis in this chapter is enough to identify issues and probable areas of concern for resolution through an analysis of total MAGTF requirements for MHE.

Increased RTCH Requirements. The analysis in this chapter illustrates that requirements for ammunition could be as high as 15 of the 16 RTCHs typically deployed to an AOA for use by a MAF. Thus, it seems virtually certain that an analysis accounting for RTCH requirements for other containerized cargo and for RTCH non-availability due to mechanical failure and hostile actions will show a requirement for additional RTCHs.

Decreased RTFL Requirements. The analysis in this study shows that a transition from breakbulk to containerized ammunition decreases requirements for RTFLs. This is because loading/offloading tasks performed by RTFLs for breakbulk ammunition handling are performed by container handlers when the ammunition is containerized. Note that this does not eliminate the requirement for RTFLs since all containers must be unstuffed and their contents handled in breakbulk form. Still, if the currently planned quantities of MHE in the FLS are adequate for breakbulk ammunition, then the analysis implies that RTFLs could be traded out of the force to provide some or all of the resources required for additional RTCHs. However, whether currently planned numbers of RTFLs are adequate for breakbulk ammunition--in view of other requirements--is beyond the scope of this study.

Personnel Requirements. Additional trained personnel will be required to operate and maintain any additional RTCHs added to the MAF. Some or all of these personnel spaces may become available by reduced requirements to operate and maintain RTFLs. Even if no additional spaces are required, some increased training will be required as the RTCH is somewhat more difficult to operate and maintain than the RTFL. Further, additional analyses will be required to determine current MAF personnel capabilities to operate available MHE equipment on a sustained basis. In particular, the analysis in this study assumed equipment could be operated 20 hours per day over an extended period. This would require at least two full crews for each equipment item.

Equipment Distribution. The probable requirement for additional RTCHs identified in this study occurs at ASPs, field ammunition dumps, and bomb dumps. ASPs and field ammunition dumps are operated by the AmmunitionCom-

pany from the Supply Battalion of the CSSE. Bomb dumps are operated by the H&MS of the ACE. Neither the Ammunition Company nor the H&MS have organic MHE, however. MHE is provided to the Ammunition Company by the Landing Support Battalion or the H&S Battalion of the CSSE. MHE for bomb dumps is provided by the Marine Wing Support Group (MWSG). All RTCHs are currently located in the Landing Support Battalion, which does not normally provide MHE to the ACE. Thus, there are three reasonable alternatives for locating the additional RTCHs within the MAF organization:

- Landing Support Battalion - Adding all new RTCHs here would maintain a central location for maintenance skills and spare parts peculiar to the RTCH, but would require the Landing Support Battalion to provide equipment to bomb dumps.
- Landing Support Battalion and MWSG - This alternative would preserve the current organizational relationships for providing MHE to the Ammunition Company and the H&MS, but the RTCH would be a new item of equipment for the MWSG.
- Ammunition Company and H&MS - Adding RTCHs to these organizations would provide them directly to the units that need them. This would eliminate requirements to attach personnel and equipment from other units to provide the RTCHs that will always be needed by the Ammunition Company and the H&MS to operate ASPs and bomb dumps handling containerized ammunition. If permanently assigning RTCHs to the Ammunition Company and the H&MS makes sense, then it would also seem to make sense to provide RTFLs to these units. RTFLs, with personnel to operate and maintain them, could be permanently reassigned from the units that normally provide them on a temporary basis. The idea of permanently assigning RTFLs to the Ammunition Company and H&MS is independent of ammunition containerization, however, since these units require RTFLs to operate ASPs and bomb dumps whether ammunition is containerized or not.

4. Implications of New Equipment Items

Marine Corps adoption of flat racks, a shooting boom forklift, or a self-loading container hauler as elements of the FLS would significantly alter the analysis concerning the merits of carrying containers to forward nodes in the resupply network. Because the analysis in this study hinges on the requirement to have at least one (and preferrably two) RTCHs at any node receiving containerized ammunition; it shows that this is not economical from the standpoint of MHE requirements if the required throughput of the node is small. These new items of equipment would reduce the need for the RTCH at the receiving node:

- Flat racks could be loaded on the MK48/MK14 at an ASP using a RTCH and then offloaded pallet-by-pallet at the receiving node using an RTFL. This offers the improved turn around time of MK48/MK14 assets associated with loading containerized ammunition instead of breakbulk ammunition (1 lift vice approximately 22 lifts) without the requirement for a RTCH at small receiving nodes. Flat racks also offer the advantage of single-lift off-loading at receiving nodes large enough to justify the assignment of RTCH assets instead of RTFLs to perform the offloading function. Once flat racks are offloaded from the MK48/MK14 chassis, they are easier to unstuff than ISO containers because the pallets are more easily accessed by MHE. Also, if flat racks are unstuffed off-chassis, they require fewer MK48/MK14s for retrograde than ISO containers.

- Shooting boom forklifts could be used at the receiving node to unstuff ISO containers without removing the container from the MK48/MK14. If receiving nodes were equipped with the shooting boom forklift, then the MK48/MK14 savings associated with single lift loading could be achieved without the penalty of requiring a RTCH at small receiving nodes. The shooting boom forklift is also more efficient at unstuffing ISO containers than the 4K RTFL, and is more efficient than the 4K RTFL at offloading break-bulk ammunition from the MK48/MK14 chassis or from flat racks. Additional analysis is required to determine if and when it would be advantageous to employ the RTCH instead of the shooting boom forklift to perform the offloading at the receiving node, depending on whether flat racks or enclosed ISO containers were employed.

- Self-Loading Container Haulers would eliminate RTCH requirements for loading and offloading containers. Some RTCHs would still be required for moving containers to and from storage at large ASPs, but small forward nodes could handle containerized ammunition without a RTCH. The self-loading container haulers would drop off full containers at the forward node and pick up empty containers for retrograde. This offers savings on RTCH requirements as compared to delivery of containers using the MK48/MK14 and offers savings in transporter requirements resulting from decreased loading/offloading times as compared to breakbulk delivery. The use of self-loading container haulers would allow equipment-efficient loading/offloading at any node or using unit regardless of size. It would not make sense, however, to deliver a container to a unit that would burden the unit with more ammunition than it could consume or assimilate before being required to move.

IX. SUMMARY AND CONCLUSIONS

A. CONCEPT DEVELOPMENT

The shipping industry has modernized to take advantage of efficiencies and economies associated with containerized cargo. Some container ships are designed to handle cargo in standard 8' x 8' x 20' ISO containers. Containerships are becoming more attuned to 40' containers, and some modifications will be needed for these ships to accommodate 20-footers. The Marine Corps anticipates that ammunition (and other cargo) delivered to an AOA by commercial ships will increasingly consist of palletized ammunition packaged in these 20-foot containers. The containers are part of the transportation system and are intended for reuse. DoD policy encourages the use of containers to expedite shipping within a theater of operations, but discourages the use of containers for storage.

Containerized ammunition is expected to arrive at the beach as part of the assault follow-on echelon (AFOE) and during subsequent resupply operations. While the exact amount of ammunition to be containerized is uncertain and scenario dependent, a reasonable estimate for the most demanding requirement for container handling equipment is that all ammunition for these phases of an amphibious operation will be delivered in containers.

For purposes of this study, the nominal amount of ammunition that can be packaged in an ISO container is termed a Container Equivalent Unit (CEU). Expressing ammunition requirements in CEUs per day, the resupply requirements for a typical MAF deployment are dominated by aircraft and artillery as shown in Table IX-1. Whether delivered to the beach in containers or in breakbulk (palletized) form, ammunition must be delivered through the resupply network to using units in the AOA.

TABLE IX-1.

MAF AMMUNITION RESUPPLY REQUIREMENTS

	Sustaining Rates	Intense Rates
Class V(W)		
Artillery	23.4	59.4
Other	9.6	19.2
	33.0	78.6
Class V(A)		
Bombs	48.9	61.2
Missiles	26.8	33.5
Other	9.1	11.4
	84.8	106.1
Total	117.8	184.7

The introduction of containerized cargo creates requirements in the AOA to handle full containers, unstuffed containers, and retrograde empty containers. With proper equipment in the AOA, however, large quantities of ammunition can be handled more efficiently in containers than in breakbulk form. The Marine Corps' Field Logistics System (FLS) contains equipment items intended to provide container handling capabilities.

The key FLS equipments for handling containerized ammunition are the lightweight amphibious container handler (LACH), the MK48/MK14 logistics vehicle system, the rough terrain container handler (RTCH), and the 4000-lb rough terrain forklift (4K RFTL). The MK48/MK14 is designed to haul both standard ISO containers and palletized loads. The LACH can offload fully loaded containers from beached landing craft and load them on MK48/MK14s for movement inland. Alternatively, loaded containers can be placed on MK48/MK14s with shipboard cranes and brought ashore over the Navy-operated elevated causeway (ELCAS). The RTCH can load and unload fully loaded containers from the MK48/MK14 and can be used to move containers to and from storage areas at an ASP or munition dump. The 4K RTFL can be used to unstuff containers, and to move palletized ammunition. A MAF has 12 LACHS, 6 RTCHS, 116 4K RTFLS, AND 145 MK48/MK14s. These items are also aboard

Maritime Pre-position Ships (MPS); a MAF deployed with a typical MPS, for example, would have an additional 4 LACHs, 10 RTCHs, 24 4K RTFLs, and 48 MK48/MK14s.

An important consideration in handling containerized ammunition is where the containers should be unstuffed. Theoretically, containers could be unstuffed at the beach and all ammunition could be carried forward in breakbulk form. At the other extreme, all ammunition could be delivered to using units in containers. Intermediate solutions would unstuff containers at ASPs and ammunition dumps.

Because space is usually at a premium at the BTP, standard practice is to clear the beach of incoming materiel as rapidly as possible. Because considerable space is required to unstuff large numbers of ammunition containers, these operations should be conducted at ASPs or ammunition dumps inland. Carrying containers inland to the ASP also makes more efficient use of MHE and transporters because containerized ammunition can be loaded and offloaded much more rapidly than the same amount of palletized ammunition.

If containerized ammunition is available at an ASP and the contents of these containers are to be shipped to a dump for issue in breakbulk form, then whether or not it pays to ship the ammunition from the ASP to the dump in containers depends on the throughput of ammunition required. Shipping containerized ammunition rather than breakbulk ammunition creates requirements for the RTCH and eliminates requirements for the 4K RTFL to load/offload transporters. Based on life cycle costs, a reduction of two 4K RTFLs for one additional RTCH is a favorable trade. The analysis in Chapter VII indicates that these kinds of savings can be achieved only if the required delivery rate to the dump is more than about 15 CEUs per day. A delivery rate of 15 CEUs per day could be handled by a single RTCH at the dump, but if this RTCH were to break down or become damaged, then a costly bottleneck in the resupply system could result. As a rule of thumb, therefore, shipping containers forward is advisable when the throughput exceeds about 30 CEUs per day and justifies having two RTCHs at the dump.

B. THE PROPOSED CONCEPT

The proposed concept describes procedures and equipment for handling containerized ammunition from the arrival of containers at the BTP through the issue of container contents in breakbulk form at retail supply points (ASPs, bomb dumps, or field munition dumps). The major elements of the concept are:

- Retail supply points will be established as convenient, under current doctrine, for handling breakbulk ammunition, and are not necessarily configured to handle containerized ammunition.
- At least one ASP will be established prior to AFOE offloading to handle containerized ammunition. Other retail supply nodes may be configured to handle containerized ammunition if their expected throughput exceeds the contents of 15 containers per day, and should be configured to handle containers if their throughput exceeds the contents of 30 customers per day.
- Retail supply points configured to handle containerized ammunition are equipped with RTCHs and layed out to provide areas for offloading and storing full containers, unstuffing containers, and storing and loading empty containers for retrograde.
- Incoming containers will be loaded on transporters and cleared from the BTP as rapidly as possible; an element of the CSSE responsible for controlling all containers in the AOA will operate a control point in the BSA and direct transporters with ammunition containers to an ASP.
- At the ASP, incoming transporters will be directed to the container offloading site at the ASP or, if possible, sent directly to a forward bomb or ammunition dump configured to handle containers.
- Once containers reach their destination, they will be unstuffed and retrograded as soon as practical.

C. CONCLUSIONS

1. The proposed concept can be fully implemented using current FLS equipments:

- The MK48/MK14 is used to transport containerized ammunition forward and retrograde empty containers.
- The LACH is used to load/offload the MK48/MK14 at the BTP. (LACHs may not be required if port facilities or an ELCAS are available)

- The RTCH is used to handle containers at ASPs and dumps configured to handle containerized ammunition; container handling tasks include loading of offloading containers from the MK48/MK14 and moving containers to and from storage and unstuffing sites.
- The 4K RTFL is used to unstuff containers and handle breakbulk ammunition; breakbulk handling tasks include moving palletized ammunition to and from storage and loading it onto trucks.

2. With currently planned assets, the number of RTCHs is the most likely critical factor in limiting the Marine Corps' ability to handle containerized ammunition in the AOA. Even assuming no RTCHs are lost to mechanical failure or enemy action and none are required for other purposes, the requirement for RTCHs to handle ammunition containers could virtually equal the total number planned for a typical MAF deployment.

3. To specify changes in Tables of Organization and Tables of Equipment, the Marine Corps will have to address issues beyond the scope of this study to determine:

- Requirements for handling containers other than those containing ammunition
- What percentage of the ammunition resupply requirements will be delivered to the beach in ISO containers
- Planning factors for equipment availability due to mechanical failures and enemy action
- Planning factors for the numbers of hours in a workday for both personnel and equipment

4. Several items of equipment are worthy of further analysis and testing as offering improved efficiencies over current FLS components. These items are:

- <u>Flat Racks</u> - an alternative to the ISO container offering more efficient use of space on container ships and relative ease for unstuffing and retrograding.
- <u>Shooting-boom Forklift</u> - an alternative to the 4K RFTL offering 2 or 3 times the productivity for unstuffing ISO containers and the ability to unstuff containers without offloading them from the MK48/MK14.

- Self-Loading Container Hauler - an alternative to the MK48/MK14 container hauler that can pick up and drop off containers by itself, thereby reducing requirements for the RTCH at ASPs and allowing delivery of containerized ammunition to small dumps or units having no RTCH assets.
- Slip Sheet Ammunition Handling System - a packaging system that allows rapid removal of ammunition from ISO containers.
- Straddle Carriers - an alternative to the LACH for offloading landing craft, an alternative to the RTCH for container handling at ASPs, and an alternative to the MK48/MK14 for transporting containers over short distances.

5. Small and intermediate sized containers are not an attractive means for routine transport of ammunition to user units. However, this will not preclude the use of such containers for some emergency and/or special operations. While the use of these containers places an additional burden on the logistics system to stuff, unstuff, and retrograde the smaller containers. However, limited use of small containers for emergency ammunition resupply by helicopter appears to be attractive.

D. PRIORITY OF REQUIRED ACTIONS

The most probable deficiency identified in this study is the potential shortage of RTCH assets to handle containerized ammunition. The Marine Corps should take the following actions to reduce the uncertainties and eliminate this potential shortfall:

- Determine requirements for RTCH assets to handle other types of containerized cargo
- Determine whether new items of equipment (flat racks, shooting boom, forklift, or a self-loading container hauler) will be added to the FLS to reduce RTCH requirements
- Acquire and field required container handling equipment

Appendix A

SOURCE DATA FOR MAF BUILDUP ASHORE

Table A-1 illustrates the number of MAF personnel arriving ashore per day based on the landing priority table and troop list shown in MARCORS-1A [Ref. 2]. This table illustrates the general trend of the buildup ashore only and should not be interpreted as representing exact numbers of personnel ashore. The MARCORS-1A source data used to construct this table are scenario dependent and therefore are not the same for all MAF-sized operations. In addition, since the landing priority table does not specifically identify the arrival times for fixed-wing air groups, the study team assumed the arrival times shown in footnote 2, Table A-2.

TABLE A-1. NUMBER OF PERSONNEL ARRIVING ASHORE

Element	D	D+1	D+2	D+3	D+4	D+5	D+6	D+7	D+8......D+12		D+15	D+30
GCE[1]	12,082	-	5,950	-	-	120	1,611	-	170	-	-	-
ACE[2]	308	246	-	24	-	5,038	1,384	-	2,722	2,703	2,703	2,702
CSSE[3]	-	2,630	-	366	543	1,598	2,843	1,087	4,472	-	-	1,300

Table A-2 is constructed from Table A-1 and shows the cumulative GCE, ACE, and CSSE buildup ashore. These values are represented graphically in Figure III-1.

TABLE A-2. CUMULATIVE PERSONNEL ASHORE

Element	D	D+1	D+2	D+3	D+4	D+5	D+6	D+7	D+8.......	D+12	D+15	D+30
GCE[1]	12,082	12,082	18,032	18,032	18,032	18,152	19,763	19,763	19,933	19,933	19,933	19,933
ACE[2]	308	554	554	578	578	5,616	7,000	7,000	9,722	12,425	15,128	17,830
CSSE[3]	-	2,630	2,630	2,996	3,539	5,137	7,980	9,067	13,539	13,539	13,539	14,839
Total	12,390	15,266	21,216	21,606	22,149	28,905	34,743	35,830	43,194	45,897	48,600	52,602

[1] Included command element figures.

[2] Assumes one VA MAG arrives on each of the following days: D+12, D+15, D+30.
Assumes one VH MAG arrives on each of the following days: D+5, D+8.

[3] Includes Naval support forces.

Appendix B

CALCULATION OF AMMUNITION REQUIREMENTS

A. GENERAL

This appendix details the calculation of MAF and MAB ammunition requirements based on source data provided by the Marine Corps. The data have been aggregated into general categories of ammunition to illustrate the areas of large ammunition expenditure. In this respect, the aggregated quantities shown should be interpreted as relative estimates and not absolute values. The general categories of Class V ammunition used in this report are:

- Class V(W)
  - -- Small arms (SA)
  - -- Mortars (M)
  - -- Tanks (T)
  - -- Artillery (A)
  - -- Demolitions (D)
  - -- Antitank (AT)
  - -- Anti-air missiles (AA)
  - -- Light-armored vehicles (LAV).
- Class V(A)
  - -- Bombs (B)
  - -- Missiles (MI)
  - -- Rockets (R)
  - -- Gun ammunition (G)
  - -- ECM devices (E).

B. MAF REQUIREMENTS

1. Intense Rate

Intense rate ammunition requirements are calculated by adding together the weight (pounds) of each DODIC in a given category and dividing that sum by 2,000 pounds per short ton (ST). These calculations are based on data

provided by Headquarters Marine Corps. These data are shown in Table B-1 for all Class V(W) (except the LAV) and in Table B-2 for the LAV. Class V(A) data are classified at the DODIC level and are not shown directly in this report. The aggregated Class V(A) data, however, are unclassified and appear in Table B-3. Based on these data, the intense rate calculation for the small arms (SA) computation is:

$$SA = \frac{\Sigma\text{(all DODICs in Table B-1 that are labeled SA)}}{2,000}$$

$$= \frac{59957 + 11490}{2,000} \approx 36 \text{ ST}$$

where: 59957 is the sum of the first 16 items on p.1 of Table B-1 and 11490 is the sum of the items on p.5 of Table B-1.

The remaining intense rate calculations are performed similarly and the results are shown below:

$$M = \frac{93643}{2,000} \approx 47 \text{ ST}$$

$$T = \frac{31653}{2,000} \approx 16 \text{ ST}$$

$$A = \frac{1402332}{2,000} + \frac{315819}{2,000} + \frac{46008}{2,000} = 701 + 158 + 23 \approx 882^{*}$$

$$D = \frac{209356}{2,000} \approx 105 \text{ ST}$$

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*Because of the density differences in artillery projectiles, propellants, and fuzes, their short-ton values will be used separately in the container calculations shown in Appendix B. The artillery short-ton calculation is the sum of the projectile short tons, propellant short tons, and fuze/primer short tons.

TABLE B-1. MAF INTENSE RATES FOR CLASS V(W)

DATE 5 OCT 1983 MAF 1990 PART 1

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OA011	I	CTG.12-GAGE #00 BUCKSHOT	240.00	522.00	2.17	2.14	88.90	
OA068	I	CTG.5.56MM TRACER	1640.00	50330.08	30.69	30.20	2058.50	
OA068A	I	CTG 5.56MM TRACER	1640.00	3778.07	2.30	2.27	153.01	
OA071	I	CTG 5.56MM BALL	1680.00	352161.25	209.62	211.30	14931.62	
OA071A	I	CTG 5.56MM BALL	1680.00	52893.02	31.48	31.74	2221.51	
OA131	I	CARTRIDGE 7.62 MM	800.00	57784.64	72.23	80.90	5657.11	
OA131B	I	CTG.7.62MM NATO LKD 4BAL	800.00	142557.69	178.20	165.65	13364.78	
OA136	I	CTG.7.62MM BALL NATO MAT	920.00	1890.00	2.05	2.08	156.49	SA
OA400	I	CTG.CAL.38 SPEC BALL	2400.00	522.00	0.22	0.26	21.45	
OA475	I	CTG.CAL.45 BALL	2000.00	7291.85	3.65	4.38	417.82	
OA576	I	CTG.CAL.50 LKD 4 API&I A	210.00	2724.12	12.97	16.34	1043.34	
OA576A	I	CTG.CAL.50 LKD 4 API&I A	200.00	41999.99	210.00	189.00	15749.99	
OB504	II-C	CTG 40MM GRN STAR PARA	44.00	149.17	3.39	3.86	162.44	
OB535	II-C	CTG.40MM WS PARA	44.00	295.96	6.73	7.67	322.30	
OB546	IV	CTG.40MM HE DP	72.00	3549.12	49.29	76.31	2795.28	
OB567	I	CTG.40MM TACT CS	24.00	712.20	29.67	22.86	812.76	
OB642	IV	CTG.60MM HE (LWCMS)W/MOF	16.00	2595.24	162.20	375.01	18822.21	
OC226	IV	CTG.81MM ILLUM	3.00	710.64	236.88	386.87	14015.35	
OC256	IV	CTG.81MM HE	3.00	2486.23	828.74	1345.30	44752.13	M
OC276	II-D	CTG.81MM SMK WP	3.00	461.52	153.84	274.00	8571.05	
OC508	IV	CTG.105MM HEAT-T	2.00	185.50	92.75	373.06	13170.49	
OC512	II-D	CTG.105MM SMK WP-T	2.00	43.40	21.70	73.18	3105.51	
OC519	II-B	CTG.105MM APERS-T (BEEHI	2.00	43.40	21.70	83.36	3182.66	T
OC523	SPEC	CTG.105MM APFSDS-T KE	2.00	182.00	91.00	305.76	12193.99	
OD501	SPEC	PROJ 155MM ADAM	8.00	197.64	24.70	239.64	21789.78	
OD502	SPEC	PROJ 155MM ADAM	8.00	361.80	45.22	438.68	40069.29	
OD503	SPEC	PROJ 155MM RAAMS	8.00	223.56	27.94	271.07	24647.47	
OD505	II-C	PROJ 155MM ILLUM	8.00	775.44	96.93	663.00	75799.13	
OD509	SPEC	PROJ 155MM RAAMS	8.00	329.40	41.17	399.40	36316.30	
OD510	SPEC	PROJ 155MM HE CANNON LCH	6.00	95.04	15.84	506.88	21510.69	
OD532A	SPEC	CHG PROP 155MM RB	1.00	2013.32	2013.32	2194.51	38253.00	
OD533A	II-A	CHG PROP 155MM WB	30.00	3208.77	106.96	4267.66	154235.63	A
OD540A	II-A	CHG PROP 155MM GB ZONE 2	1.00	2566.08	2566.08	5568.39	37208.14	
OD541A	II-A	CHG PROP 155MM WB	1.00	480.77	480.77	365.39	14903.94	
OD542	XI-A	PROJ 155MM GAS GB NP	8.00	500.04	62.50	427.53	51941.59	
OD544	IV	PROJ 155MM HE	8.00	2724.84	340.60	2329.73	271461.81	
OD550	II-D	PROJ 155MM SMK WP	8.00	410.40	51.30	350.89	42578.96	
OD563	VII	PROJ 155MM HE DP (ICM)	8.00	4658.04	582.25	5647.86	508890.25	
OD568	XI-A	PROJ 155MM GAS VX PERS	8.00	83.34	10.42	69.07	8656.93	

TABLE B-1. MAF INTENSE RATES FOR CLASS V(W) (Page 2)

DATE 5 OCT 1983 MAF 1990 PART 1

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
0D579	VII	PROJ 155MM HE RAP	8.00	756.00	94.50	902.51	78434.94	
0D624	SPEC	PROJ 8IN HE RAP	6.00	97.68	16.28	237.68	20398.81	
0D651	V	PROJ 8 IN HE ICM	6.00	525.48	87.58	1322.47	112802.94	
0D662	SPEC	CHG PROP 8 IN WB Z 8-9	15.00	102.56	6.84	326.15	8854.66	
0D662A	SPEC	CHG PROP 8 IN WB Z 8-9	1.00	374.61	374.61	516.96	28470.48	A
0D675	II-A	CHG PROP 8 IN GB	30.00	160.55	5.35	232.26	6036.59	
0D676A	II-A	CHG PROP 8 IN WB	1.00	525.60	525.60	678.03	27856.97	
0D680	VII	PROJ 8 IN HE	6.00	416.76	69.46	868.23	87033.25	
0D681A	IX-A	FLASH REDUCER F/8 IN	40.00	1083.76	27.09	53.43	1743.01	
0G815	SPEC	GREN SMK SCREENING (UK)	8.00	420.00	52.50	52.16	1819.98	
0G815A	SPEC	GREN SMK SCREENING (UK)	1.00	20.00	20.00	2.00	100.00	
0G900	II-J	GREN HD INC	16.00	100.35	6.27	5.08	304.21	
0G924	XI-B	GREN HD RIOT CS 1	50.00	61.67	1.23	2.50	67.83	
0G930	II-E	GREN HD SMK HC	16.00	0.05	0.00	0.00	0.14	
0G930A	II-E	GREN HD SMK HC	16.00	64161.33	4010.08	3608.43	164413.38	D
0G937	II-D	GREN HD/RIFLE SMK WP	16.00	192.14	12.01	10.78	500.38	
0G940	II-C	GREN HD SMK GREEN	16.00	207.39	12.96	13.71	580.40	
0G945	II-C	GREN HD SMK YELLOW	16.00	294.34	18.40	19.46	823.75	
0G950	II-C	GREN HD SMK RED	16.00	160.55	10.03	10.61	449.32	
0G963	XI-B	GRENADE, RIOT	16.00	16.00	1.00	0.97	33.00	
0H55T	SPEC	ROCKET 70MM HE (VIPER)	15.00	98.10	6.54	68.60	935.22	
0H55TA	SPEC	ROCKET 70MM HEAT (VIPER)	15.00	109.80	7.32	76.78	1046.68	
~~0H993~~	~~I~~	~~WARHEAD 5" HE~~	~~36.00~~	~~2603.00~~	~~72.00~~	~~[illegible]~~	~~[illegible]~~	AT
~~0U143~~	~~II-B~~	~~RKT MOTOR 5 IN~~	~~1.00~~	~~3.60~~	~~3.00~~	~~[illegible]~~	~~[illegible]~~	
~~0U143A~~	~~II-B~~		~~1.00~~	~~1.00~~	~~1.00~~	~~0.02~~	~~200.00~~	
~~0U271~~	~~SPEC~~	~~ROCKET MTR 5 INCH~~	~~24.00~~	~~2592.00~~	~~108.00~~	~~[illegible]~~	~~[illegible]~~	
~~0U329~~	~~I~~	~~FUZE ROCKET M414A1~~	~~16.00~~	~~2592.00~~	~~162.00~~	~~232.90~~	~~[illegible]~~	
0K092	IV	MINE APERS	4.00	203.10	50.77	43.16	2068.57	
0K092E	IV	MINE APERS	4.00	215.50	53.87	42.00	2424.37	
0K143	X-B	MINE AP	6.00	101.60	16.93	26.95	973.66	
0K180	VII	MINE AT HE HVY	30.00	91.40	3.05	126.13	4691.86	
0K181	VII	MINE AT HE HVY W/FZ M607	48.00	101.60	2.12	89.54	2476.50	
0K250	VII	MINE AT NM	48.00	10.17	0.21	11.86	344.54	
0K867	II-E	SMK POT FLOATING HC	12.00	0.52	0.04	1.48	30.10	
0L283	II-C	SIG. SMK.BILL.	108.00	3.20	0.03	0.11	3.03	
0L306	II-C	SIG ILLUM RED STAR CLUST	36.00	0.49	0.01	0.02	0.81	D
0L306A	II-C	SIG ILLUM GRND RED STAR	36.00	11.19	0.31	0.44	19.88	
0L307	II-C	SIG ILLUM WHITE STAR CLU	36.00	48.17	1.34	2.45	79.16	
0L311	II-C	SIG ILLUM RED STAR PARA	36.00	0.65	0.02	0.03	1.07	
0L311A	II-C	SIG ILLUM RED STAR PARA	36.00	30.27	0.84	1.19	53.79	
0L312	II-C	SIG ILLUM WHITE STAR PAR	36.00	190.65	5.30	9.70	313.34	
0L312F	II-C	SIG ILLUM WHITE STAR PAR	36.00	2.33	0.06	0.09	4.34	
0L314	II-C	SIG ILLUM GRND GRN STAR	36.00	112.53	3.13	5.73	184.94	
0L314F	II-C	SIGNAL ILLUMINATION GRDU	36.00	1.28	0.04	0.05	2.34	
0L323	II-C	SIG SMK RED PARA	36.00	0.59	0.02	0.03	0.97	
0L323A	II-C	SIG SMK GRND RED PARA	36.00	13.16	0.37	0.52	20.10	

TABLE B-1. MAF INTENSE RATES FOR CLASS V(W) (Page 3)

DATE 5 OCT 1983 MAF 1990 PART 1

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OL324	II-C	SIG SMK GRND GRN PARA	36.00	0.62	0.02	0.03	1.02	
OL324A	II-C	SIG SMK GRND GRN PARA	36.00	138.19	3.84	5.41	211.02	
OML03	SPEC	FIRING DEV MULTI-PURP DE	56.00	1.20	0.02	0.02	2.05	
OML03A	SPEC	FIRING DEV MULTI-PURP DE	56.00	0.20	0.00	0.00	0.04	
OM028	X-B	DEMO KIT BANG TORP	1.00	14.80	14.80	70.15	3048.80	
OM028A	X-B	DEMO KIT BANG TORP	1.00	0.20	0.20	0.82	39.60	
OM032	IX-B	CHG DEMO BLK 1 LB TNT	48.00	414.00	8.63	14.28	646.87	
OM039	IX-B	CHG DEMO CRATERING 40 LB	1.00	4.40	4.40	7.15	225.28	
OM039A	IX-B	CHG DEMO CRATERING 40 LB	1.00	3.00	3.00	3.60	156.00	
OM130	VIII	CAP BLAST SPEC ELEC	96.00	220.00	2.29	2.51	73.72	
OM131	VIII	CAP BLAST NON-ELEC	800.00	337.33	0.42	0.47	12.52	
OM131A	VIII	CAP BLAST NON-ELEC	3600.00	1395.33	0.39	1.51	38.75	
OM131B	VIII	CAP BLAST NON-ELEC	3600.00	0.03	0.00	0.00	0.00	
OM168	I	POWDER ACT TOOL CTG CAL.	1000.00	133.33	0.13	0.15	2.65	
OM171	I	POWDER ACT TOOL CTG CAL.	1000.00	66.67	0.07	0.07	1.33	
OM172	I	POWDER ACT TOOL CTG CAL.	1000.00	33.33	0.03	0.04	0.66	
OM420	IX-B	CHG CEMO SHAPED 15 LB	3.00	15.00	5.00	11.85	350.00	
OM421	IX-B	CHG DEMO SHAPED 40 LB	1.00	12.40	12.40	27.74	875.75	D
OM456	I	CORD DET PLIOFILM WRAP	3000.00	2733.33	0.91	3.01	75.44	
OM456A	I	CORD DET PLIOFILM WRAP	4000.00	4766.66	1.19	4.66	139.39	
OM591	IX-B	DYNAMITE MIL (STICK)	100.00	100.00	1.00	1.54	65.13	
OM598	II-J	CRYPTO EQUIP DEST INC TH	22.00	0.20	0.01	0.24	11.35	
OM598A	II-J	CRYPTO EQUIP DEST INC TH	1.00	0.40	0.40	0.44	22.00	
OM598B	II-J	CRYPTO EQUIP DEST INC TH	1.00	1.60	1.60	1.76	88.00	
OM598C	II-J	CRYPTO EQUIP DEST INC TH	1.00	2.40	2.40	2.64	132.00	
OM626A	I	FIRING DEVICE DEMO M1	150.00	30.70	0.20	0.59	15.96	
OM627	I	FIRING DEV DEMO PRESS-RE	48.00	18.40	0.38	0.46	9.90	
OM627A	I	FIRING DEV DEMO PRESS-RE	200.00	64.20	0.32	0.51	14.76	
OM627B	I	FIRING DEV DEMO PRESS-RE	200.00	0.01	0.00	0.00	0.00	
OM670	I	FUZE BLAST TIME 50-FT	400.00	800.00	2.00	2.00	57.36	
OM670A	I	FUZE BLASTING TIME	200.00	5366.66	26.83	17.70	938.63	
OM757	IX-B	CHG ASSY DEMO W/8 M112	2.00	23.50	11.75	21.10	718.71	
OM757A	IX-B	CHG ASSY DEMO W/8 M112	2.00	112.70	56.35	84.52	3211.95	
OM766	I	IGN FUZE BLAST TIME	60.00	382.27	6.37	6.35	185.82	
OM766A	I	IGN FUZE BLAST TIME	300.00	1330.93	4.44	8.87	221.73	
OM814	SPEC	DOCUMENT DESTROYER	1.00	0.02	0.02	0.35	7.62	
OM913	IX-B	CHG DEMO LINEAR HE COMP	1.00	3.90	3.90	288.60	11699.99	
ON285	I	FUZE MT	16.00	6899.03	431.19	489.83	19964.39	
ON285A	I	FUZE MT	1.00	551.75	551.75	40.33	1586.29	
ON286A	VI	FUZE MTSO	1.00	136.80	136.80	10.00	410.40	
ON296D	VI	FUZE MTSO	1.00	307.80	307.80	22.50	923.40	
ON331A	III	FUZE PD CP .025 SEC DEL	16.00	75.02	4.69	4.88	262.56	A
ON340	VI	FUZE PD	16.00	2043.90	127.74	145.12	7447.55	
ON340C	VI	FUZE POINT DETONATING PD	1.00	123.12	123.12	9.00	430.92	
ON340E	VI	FUZE PD	1.00	393.12	393.12	28.74	1375.92	
ON340G	VI	FUZE PD	1.00	1050.08	1050.08	76.76	3675.28	

TABLE B-1. MAF INTENSE RATES FOR CLASS V(W) (Page 4)

DATE 5 OCT 1983 MAF 1990 PART 1

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
ON463B	VI	FUZE PROX (VT)	1.00	973.51	973.51	78.84	3832.71	
ON464	SPEC	FUZE PROX (VT)	16.00	400.68	25.04	28.45	1309.74	
ON523	III	PRIMER PERC F/M198 & SP'	400.00	12264.82	30.66	33.11	1060.91	A
ON523A	III	PRIMER PERC F/M198 & SP'	400.00	10694.24	26.74	29.94	874.79	
ON525	III	PRIMER PERC	400.00	12833.09	32.08	34.65	1110.06	
OPA66	X-C	GUIDED MISSILE, SURFACE	8.00	67.54	8.44	477.82	8585.50	AT
OPL23	IV	GUIDED MISSILE & LAUNCHE	1.00	34.70	34.70	286.31	2909.35	
OVX80	X-C	IMPROVED HAWK MISSILE	1.00	22.00	22.00	3320.63	71389.88	AA
OVX97	SPEC	STINGER GUIDED MISSLE SY	1.00	1.89	1.89	12.41	198.76	
TOTAL						56326.12	2725476.00	

*REPLENISHMENT RDS EQUAL (WPNQTY) X (ITEMS/WPNQTY/DAY)

TABLE B-1. MAF INTENSE RATES FOR CLASS V(W) (Page 5)

DATE 5 UCT 1983 MAF 1990 PT 2

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OA011	I	CTG.12-GAGE #00 BUCKSHOT	240.00	150.00	0.63	0.61	25.54	SA
OA068	I	CTG.5.56MM TRACER	1640.00	3318.40	2.02	1.99	135.72	
OA068A	I	CTG 5.56MM TRACER	1640.00	2392.23	1.46	1.44	96.89	
OA071	I	CTG 5.56MM BALL	1680.00	23219.02	13.82	13.93	984.49	
OA071A	I	CTG 5.56MM BALL	1680.00	33491.18	19.94	20.09	1406.63	
OA131	I	CARTRIDGE 7.62 MM	800.00	30728.30	38.41	43.02	3008.30	
OA131B	I	CTG.7.62MM NATO LKD 4BAL	800.00	26877.45	33.60	31.23	2519.76	
OA400	I	CTG.CAL.38 SPEC BALL	2400.00	3.00	0.00	0.00	0.12	
OA475	I	CTG.CAL.45 BALL	2000.00	1797.40	0.90	1.08	102.99	
OA576	I	CTG.CAL.50 LKD 4 API&1 A	210.00	194.58	0.93	1.17	74.52	
OA576A	I	CTG.CAL.50 LKD 4 API&1 A	200.00	8066.66	40.33	36.30	3025.00	
OB504	II-C	CTG 40MM GRN STAR PARA	44.00	4.02	0.09	0.10	4.38	
OB535	II-C	CTG.40MM WS PARA	44.00	7.98	0.18	0.21	8.69	
OB546	IV	CTG 40MM HE DP	72.00	95.68	1.33	2.06	75.36	
OB567	I	CTG 40MM TACT CS	24.00	19.20	0.80	0.62	21.91	

TABLE B-1. MAF INTENSE RATES FOR CLASS V(W) (Page 6)

DATE 5 OCT 1983 MAF 1090 PT 2

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OC226	IV	CTG.81MM ILLUM	3.00	78.96	26.32	42.99	1557.26	
OC256	IV	CTG.81MM HE	3.00	276.25	92.08	149.48	4972.45	M
OC276	II-D	CTG.81MM SMK WP	3.00	51.28	17.09	30.44	952.34	
OG815A	SPEC	GREN SMK SCREENING (UK)	1.00	4.00	4.00	0.40	20.00	
OG900	II-J	GREN HD INC	16.00	28.42	1.78	1.44	86.15	
OG924	XI-B	GREN HD RIOT CS 1	50.00	1.67	0.03	0.07	1.83	
OG940	II-C	GREN HD SMK GREEN	16.00	58.73	3.67	3.88	164.37	
OG945	II-C	GREN HD SMK YELLOW	16.00	83.36	5.21	5.51	233.31	
OG950	II-C	GREN HD SMK RED	16.00	45.47	2.84	3.01	127.76	
OG963	XI-B	GRENADE,RIOT	16.00	1.60	0.10	0.10	3.30	
OK092A	IV	MINE APERS	4.00	30.00	7.50	5.85	337.50	
OK867	II-E	SMK POT FLOATING HC	12.00	0.10	0.01	0.30	6.02	
OL306	II-C	SIG ILLUM RED STAR CLUST	36.00	8.53	0.24	0.43	14.01	
OL307	II-C	SIG ILLUM WHITE STAR CLU	36.00	13.64	0.38	0.69	22.42	
OL311	II-C	SIG ILLUM RED STAR PARA	36.00	11.37	0.32	0.58	18.68	
OL312	II-C	SIG ILLUM WHITE STAR PAR	36.00	54.00	1.50	2.75	88.75	
OL312F	II-C	SIG ILLUM WHITE STAR PAR	36.00	40.55	1.13	1.59	75.46	
OL314F	II-C	SIGNAL ILLUMINATION GROU	36.00	22.17	0.62	0.87	40.64	
OL323	II-C	SIG SMK RED PARA	36.00	10.23	0.28	0.52	16.81	
OL324	II-C	SIG SMK GRND GRN PARA	36.00	10.80	0.30	0.55	17.75	
OML04	SPEC	CUTTER POWDER ACTUATED M	12.00	0.40	0.03	0.03	1.67	
OMX14	IX-B	CONT KIT CAVITY CHGS	1.00	0.03	0.03	0.08	2.20	
OM028A	X-B	DEMO KIT BANG TORP	1.00	0.20	0.20	0.82	39.60	
OM032	IX-B	CHG DEMO BLK 1 LB TNT	48.00	126.00	2.63	4.35	196.87	
OM039A	IX-B	CHG DEMO CRATERING 40 LB	1.00	3.00	3.00	3.60	156.00	D
OM130	VIII	CAP BLAST SPEC ELEC	96.00	95.00	0.99	1.08	31.83	
OM130B	VIII	CAP BLAST SPEC ELEC	900.00	8.00	0.01	0.05	1.01	
OM131	VIII	CAP BLAST NON-ELEC	800.00	146.67	0.18	0.21	5.44	
OM131A	VIII	CAP BLAST NON-ELEC	3600.00	151.67	0.04	0.16	4.21	
OM131C	VIII	CAP BLAST NON-ELEC	3600.00	0.10	0.00	0.00	0.00	
OM131N	VIII	CAP BLAST NON-ELEC	3600.00	12.00	0.00	0.01	0.33	
OM168	I	POWDER ACT TOOL CTG CAL	1000.00	133.33	0.13	0.15	2.65	
OM171	I	POWDER ACT TOOL CTG CAL.	1000.00	66.67	0.07	0.07	1.33	
OM172	I	POWDER ACT TOOL CTG CAL	1000.00	33.33	0.03	0.04	0.66	
OM174	I	CTG CAL 50 IMPULSE ELEC	154.00	5.60	0.04	0.04	1.82	
OM418	IX-B	CHG DEMO SHAPED	4.00	1.20	0.30	0.33	7.03	
OM420A	IX-B	CHG DEMO SHAPED 15 LB	3.00	0.20	0.07	0.12	4.40	
OM421A	IX-B	CHG DEMO SHAPED 40 LB	1.00	4.33	4.33	8.10	329.33	
OM456	I	CORD DET PLIOFILM WRAP	3000.00	666.67	0.22	0.73	18.40	
OM456A	I	CORD DET PLIOFILM WRAP	4000.00	583.33	0.15	0.57	17.06	
OM456C	I	CORD DET PLIOFILM WRAP	4000.00	133.33	0.03	0.13	3.90	
OM500	I	CUTTER CTG ACT REEFLINE	40.00	72.00	1.80	1.97	65.33	
OM504	I	CUTTER CTG ACT REEFLINE	40.00	84.00	2.10	2.30	91.70	
OM591	IX-B	DYNAMITE MIL (STICK)	100.00	100.00	1.00	1.54	65.13	
OM626A	I	FIRING DEVICE DEMO M1	150.00	5.00	0.03	0.10	2.60	
OM627	I	FIRING DEV DEMO PRESS-RE	48.00	8.40	0.17	0.21	4.52	

TABLE B-1. MAF INTENSE RATES FOR CLASS V(W) (Page 7)

DATE 5 OCT 1983 MAF 1990 PT 2

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OM627A	I	FIRING DEV DEMO PRESS-RE	200.00	7.00	0 03	0.06	1 61	
OM670	I	FUZE BLAST TIME 50-FT	400.00	316 67	0.79	0 79	22.70	
OM670A	I	FUZE BLASTING TIME	200.00	600.00	3.00	1 98	104 94	
OM670C	I	FUZE BLAST TIME 50-FT	200.00	133.33	0.67	0 44	23.32	
OM757	IX-B	CHG ASSY DEMO W/8 M112	2.00	10.00	5.00	8 98	305.83	
OM757A	IX-B	CHG ASSY DEMO W/8 M112	2.00	12.25	6.12	9 19	349.12	D
OM757C	IX-B	CHG ASSY DEMO W/8 M112	2.00	0 87	0.43	0 65	24 70	
OM766	I	IGN FUZE BLAST TIME	60.00	162 67	2 71	2.70	79.07	
OM766A	I	IGN FUZE BLAST TIME	300.00	144.67	0.48	0 96	24 10	
OM766C	I	IGN FUZE BLAST TIME	300.00	20.00	0 07	0.13	3 33	
OM862	II-C	SQUIB ELEC DUPONT 1.5 GR	200.00	1 67	0 01	0 01	0.23	
OPA66	X-C	GUIDED MISSILE, SURFACE	8.00	15.01	1.88	106 18	1907 89	AT
TOTAL						564.14	24148.38	

*REPLENISHMENT RDS EQUAL (WPNQTY) X (ITEMS/WPNQTY/DAY)

$$AT = \frac{15385}{2,000} \approx 8 \text{ ST}$$

$$AA = \frac{71589}{2,000} \approx 36 \text{ ST}$$

TABLE B-2. LAV COMBAT RATES*

DODIC	Basis of Issue	TAM No.	Assault 1-DOA	Assault 30-DOA	Sustaining 1-DOA	Sustaining 30-DOA	Basic Allowance**	Basic Load
A068	M16A1 Rifle	E1440	**			**	10	820
A071	M16A1 Rifle	E1440	**			**	70	840
A131	M240 MG or	E0998	213.3	6400.0	106.6	3200.0	1,600	1,600
A131***	M60D MG	E0991	298.36	6962.2	107.65	3229.5		
A576***	M2 MG	E0980	97.29	2918.7	54.25	1627.5	500	500
A974	M242 Cannon LAV(25)	E0947	12.0	360.0	3.5	105.0	200	200
A975	M242 Cannon LAV(25)	E0947	43.0	1290.0	13.0	390.0	450	450
G815	2 M257 Launchers LAV(25)	E0947	4.0	120.0	2.0	60.0	16	16

*Reference 34.

**Basic allowance is part of, and not in addition to, the 1st 30-DOA assault rate. The basic load, as listed, is recommended for stowage in the LAV(25). The resource for this load is also part of the 1st DOA assault rate. M16A1 rifle rounds are listed only for displaying basic allowance and for displaying planned basic load for the LAV(25) stowage. Combat rates for the rifle are displayed in the current edition of MCO 8010.1 under the rifle subheading.

***The pintle mount on the LAV permits the installation of the M2 50-caliber MG, or the M60D 7.62-mm MG. A decision as to which weapon will be authorized/designated has not been determined as of the date of this publication.

The LAV calculations shown below are based on Table B-2:

$$LAV(25) = 55 \frac{\text{rounds}}{\text{tube}} \times 56 \text{ tubes} \times 0.5 \frac{\text{pounds}}{\text{round}} \times \frac{\text{ST}}{2{,}000 \text{ lb}} \approx 1 \text{ ST}$$

$$SA(M60D) = 298.36 \frac{\text{rounds}}{\text{tube}} \times 110 \text{ tubes} \times 0.101 \frac{\text{pounds}}{\text{round}} \times \frac{\text{ST}}{2{,}000 \text{ lb}} \approx 2 \text{ ST}$$

$$M(HE) = 49.33 \frac{\text{rounds}}{\text{tube}} \times 8 \text{ tubes} \times 17.67 \frac{\text{pounds}}{\text{round}} \times \frac{\text{ST}}{2{,}000 \text{ lb}} \approx 5 \text{ ST}$$

TABLE B-3. AGGREGATED CLASS V(A) DATA

Category	Total Pounds
Bombs (B)	1,427,302
Missiles (MI)	402,169
Rockets (R)	112,330
Gun Ammunition (G)	78,228
ECM devices (E)	62,508

Using the data of Table B-3, the Class V(A) requirements are:

$$B = \frac{1{,}427{,}302 \text{ lb}}{2{,}000 \frac{\text{lb}}{\text{ST}}} \approx 714 \text{ ST}$$

$$M = \frac{402{,}169}{2{,}000} \approx 201 \text{ ST}$$

$$R = \frac{112{,}330}{2{,}000} \approx 56 \text{ ST}$$

$$G = \frac{78{,}228}{2{,}000} \approx 39 \text{ ST}$$

$$E = \frac{62{,}508}{2{,}000} \approx 31 \text{ ST}$$

Table B-4 summarizes the Class V(W) and V(A) intense rate requirements for a MAF.

TABLE B-4. INTENSE RATE MAF REQUIREMENTS (SHORT TONS)

Category	Requirement	
Artillery	882	V(W)
Demolitions	105	V(W)
Mortars	52 (47 + 5)	V(W)
Small arms	38 (36 + 2)	V(W)
Anti-air missiles	36	V(W)
Tanks	16	V(W)
Antitank	8	V(W)
LAV(25)	1	V(W)
Bombs	714	V(A)
Missiles	201	V(A)
Rockets	56	V(A)
Gun ammunition	39	V(A)
ECM devices	31	V(A)

2. Sustaining Rate

Table B-5 is used to determine the Class V(W) sustaining rate requirements for the MAF, as shown below:

$$SA = \frac{32900}{2,000} \approx 16 \text{ ST}$$

$$M = \frac{71718}{2,000} \approx 36 \text{ ST}$$

$$T = \frac{10643}{2,000} \approx 5 \text{ ST}$$

$$A = \frac{573922}{2,000} + \frac{117003}{2,000} + \frac{19271}{2,000} = 287 + 58 + 10 \approx 355 \text{ ST}$$

$$D = \frac{170569}{2,000} \approx 85 \text{ ST}$$

TABLE B-5. MAF SUSTAINING RATES FOR CLASS V(W)

DATE 5 OCT 1983 MAF 1390 PART 1

EUROPEAN REPLENISHMENT SUSTAINING RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
0A011	I	CTG.12-GAGE #00 BUCKSHOT	240.00	522.00	2.17	2.14	88.90	
0A068	I	CTG.5.56MM TRACER	1640.00	21908.39	13.36	13.15	896.05	
0A068A	I	CTG 5.56MM TRACER	1640.00	1666.80	1.02	1.00	67.51	
0A071	I	CTG 5.56MM BALL	1680.00	153654.25	91.46	92.19	6514.93	
0A071A	I	CTG 5.56MM BALL	1680.00	23057.38	13.72	13.83	968.41	
0A131	I	CARTRIDGE 7.62 MM	800.00	32043.80	40.05	44.86	3137.09	
0A131B	I	CTG.7.62MM NATO LKD 4BAL	800.00	72326.44	90.41	84.04	6780.60	
0A136	I	CTG.7.62MM BALL NATO MAT	920.00	1890.00	2.05	2.08	156.49	
0A400	I	CTG.CAL.38 SPEC BALL	2400.00	403.68	0.17	0.20	16.59	SA
0A475	I	CTG.CAL.45 BALL	2000.00	795.47	0.40	0.48	45.58	
0A576	I	CTG.CAL.50 LKD 4 API&1 A	210.00	1519.00	7.23	9.11	581.78	
0A576A	I	CTG.CAL.50 LKD 4 API&1 A	200.00	15750.00	78.75	70.87	5906.25	
0B504	II-C	CTG 40MM GRN STAR PARA	44.00	74.78	1.70	1.94	81.44	
0B535	II-C	CTG 40MM WS PARA	44.00	188.34	4.28	4.88	205.10	
0B546	IV	CTG 40MM HE DP	72.00	1839.85	25.55	39.56	1449.06	
0B567	I	CTG.40MM TACT CS	24.00	557.89	23.25	17.91	636.66	
0B642	IV	CTG.60MM HE (LWCMS)W/MOF	16.00	1764.18	110.26	254.92	12794.88	
0C226	IV	CTG.81MM ILLUM	3.00	559.44	186.48	304.56	11033.37	M
0C256	IV	CTG.81MM HE	3.00	1958.04	652.68	1059.49	35244.69	
0C276	II-D	CTG.81MM SMK WP	3.00	363.60	121.20	215.87	6752.54	
0C508	IV	CTG.105MM HEAT-T	2.00	62.30	31.15	125.29	4423.30	
0C512	II-D	CTG.105MM SMK WP-T	2.00	14.70	7.35	24.79	1051.87	T
0C519	II-B	CTG.105MM APERS-T (BEEHI	2.00	14.70	7.35	28.24	1078.00	
0C523	SPEC	CTG.105MM APFSDS-T KE	2.00	61.04	30.52	102.55	4089.68	
0D501	SPEC	PROJ 155MM ADAM	8.00	144.72	18.09	175.47	15955.36	
0D502	SPEC	PROJ 155MM ADAM	8.00	65.88	8.23	79.88	7296.20	
0D503	SPEC	PROJ 155MM RAAMS	8.00	104.76	13.09	127.02	11549.78	
0D505	II-C	PROJ 155MM ILLUM	8.00	401.76	50.22	343.50	39272.01	
0D509	SPEC	PROJ 155MM RAAMS	8.00	68.04	8.50	82.50	7501.40	
0D510	SPEC	PROJ 155MM HE CANNON LCH	6.00	32.40	5.40	172.80	7333.19	
0D532A	SPEC	CHG PROP 155MM RB	1.00	694.02	694.02	756.48	13186.31	
0D533A	II-A	CHG PROP 155MM WB	30.00	1093.08	36.44	1453.79	12540.85	
0D540A	II-A	CHG PROP 155MM GB ZONE 2	1.00	1033.34	1033.34	2242.35	14983.48	
0D541A	II-A	CHG PROP 155MM WB	1.00	249.09	249.09	189.31	[illegible]721.82	A
0D542	XI-A	PROJ 155MM GAS GB NP	8.00	198.72	24.84	169.91	20642.02	
0D544	IV	PROJ 155MM HE	8.00	1126.44	140.80	963.10	112221.44	
0D550	II-D	PROJ 155MM SMK WP	8.00	172.80	21.60	147.74	17927.99	
0D563	VII	PROJ 155MM HE DP (ICM)	8.00	1807.92	225.99	2192.10	197515.06	
0D568	XI-A	PROJ 155MM GAS VX PERS	8.00	33.12	4.14	27.45	3440.34	
0D579	VII	PROJ 155MM HE RAP	8.00	432.00	54.00	515.72	44819.99	
0D624	SPEC	PROJ 8IN HE RAP	6.00	37.92	6.32	92.27	7918.95	
0D651	V	PROJ 8 IN HE ICM	6.00	195.48	32.58	491.96	41963.02	
0D662	SPEC	CHG PROP 8 IN WB Z 8-9	15.00	39.82	2.65	126.61	3437.44	
0D662A	SPEC	CHG PROP 8 IN WB Z 8-9	1.00	151.23	151.23	208.69	11493.32	
0D675	II-A	CHG PROP 8 IN GB	30.00	64.81	2.16	93.76	2436.93	

TABLE B-5. MAF SUSTAINING RATES FOR CLASS V(W) (Page 2)

DATE 5 OCT 1983 MAF 1390 PART 1

EUROPEAN REPLENISHMENT SUSTAINING RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OD676A	II-A	CHG PROP 8 IN WB	1.00	211.41	211.41	272.71	11204.52	
OD680	VII	PROJ 8 IN HE	6.00	184.68	30.78	384.74	38567.32	A
OD681A	IX-A	FLASH REDUCER F/8 IN	40.00	435.86	10.90	21.49	700.99	
OG815	SPEC	GREN SMK SCREENING (UK)	8.00	210.00	26.25	26.08	909.99	
OG815A	SPEC	GREN SMK SCREENING (UK)	1.00	10.00	10.00	1.00	50.00	
OG900	II-J	GREN HD INC	16.00	100.35	6.27	5.08	304.21	
OG924	XI-B	GREN HD RIOT CS 1	50.00	61.67	1.23	2.50	67.83	
OG930	II-E	GREN HD SMK HC	16.00	0.05	0.00	0.00	0.14	
OG930A	II-E	GREN HD SMK HC	16.00	55277.51	3454.84	3108.81	141648.56	D
OG937	II-D	GREN HD/RIFLE SMK WP	16.00	100.65	6.29	5.65	262.10	
OG940	II-C	GREN HD SMK GREEN	16.00	120.42	7.53	7.96	337.01	
OG945	II-C	GREN HD SMK YELLOW	16.00	173.93	10.87	11.50	486.76	
OG950	II-C	GREN HD SMK RED	16.00	86.97	5.44	5.75	243.38	
OG963	XI-B	GRENADE,RIOT	16.00	16.00	1.00	0.97	33.00	
OH55T	SPEC	ROCKET 70MM HE (VIPER)	15.00	21.96	1.46	15.36	209.35	
OH55TA	SPEC	ROCKET 70MM HEAT (VIPER)	15.00	27.45	1.83	19.19	261.67	
~~[illegible]~~	~~I~~	~~WARHEAD 5" HE~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	
~~[illegible]~~	~~II-B~~	~~RKT MOTOR 5 IN~~	~~1.00~~	~~1.00~~	~~1.00~~	~~[illegible]~~	~~[illegible]~~	AT
~~[illegible]~~	~~II-B~~		~~1.00~~	~~0.53~~	~~0.53~~	~~[illegible]~~	~~[illegible]~~	
~~[illegible]~~	~~SPEC~~	~~ROCKET MTR 5 INCH~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	
~~[illegible]~~	~~I~~	~~FUZE ROCKET M414A1~~	~~16.00~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	
OK0[illegible]	IV	MINE APERS	4.00	84.47	21.12	17.95	860.29	
OK0[illegible]E	IV	MINE APERS	4.00	129.00	32.25	25.14	1451.25	
OK143	X-B	MINE AP	6.00	42.20	7.03	11.20	404.42	
OK180	VII	MINE AT HE HVY	30.00	38.00	1.27	52.44	1950.66	
OK181	VII	MINE AT HE HVY W/FZ M607	48.00	42.20	0.88	37.19	1028.62	
OK250	VII	MINE AT NM	48.00	4.23	0.09	4.94	143.46	
OK867	II-E	SMK POT FLOATING HC	12.00	0.35	0.03	0.99	20.07	
OL283	II-C	SIG. SMK BILL.	108.00	3.20	0.03	0.11	3.03	
OL306	II-C	SIG ILLUM RED STAR CLUST	36.00	0.16	0.00	0.01	0.27	
OL306A	II-C	SIG ILLUM GRND RED STAR	36.00	3.95	0.11	0.15	7.02	
OL307	II-C	SIG ILLUM WHITE STAR CLU	36.00	26.09	0.72	1.33	42.88	D
OL311	II-C	SIG ILLUM RED STAR PARA	36.00	0.43	0.01	0.02	0.70	
OL311A	II-C	SIG ILLUM RED STAR PARA	36.00	19.08	0.53	0.75	33.91	
OL312	II-C	SIG ILLUM WHITE STAR PAR	36.00	148.51	4.13	7.56	244.08	
OL312F	II-C	SIG ILLUM WHITE STAR PAR	36.00	1.82	0.05	0.07	3.39	
OL314	II-C	SIG ILLUM GRND GRN STAR	36.00	76.99	2.14	3.92	126.51	
OL314F	II-C	SIGNAL ILLUMINATION GROU	36.00	0.49	0.01	0.02	0.90	
OL323	II-C	SIG SMK RED PARA	36.00	0.26	0.01	0.01	0.43	
OL323A	II-C	SIG SMK GRND RED PARA	36.00	5.92	0.16	0.23	9.04	
OL324	II-C	SIG SMK GRND GRN PARA	36.00	0.26	0.01	0.01	0.43	
OL324A	II-C	SIG SMK GRND GRN PARA	36.00	5.92	0.16	0.23	9.04	
OML03	SPEC	FIRING DEV MULTI-PURP DE	56.00	0.90	0.02	0.02	1.54	
OML03A	SPEC	FIRING DEV MULTI-PURP DE	56.00	0.05	0.00	0.00	0.01	
OM028	X-B	DEMO KIT BANG TORP	1.00	14.20	14.20	67.31	2925.20	
OM028A	X-B	DEMO KIT BANG TORP	1.00	0.10	0.10	0.41	19.80	

TABLE B-5. MAF SUSTAINING RATES FOR CLASS V(W) (Page 3)

DATE 5 OCT 1983 MAF 1990 PART 1

EUROPEAN REPLENISHMENT SUSTAINING RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OM032	IX-B	CHG DEMO BLK 1 LB TNT	48.00	414.00	8.63	14.28	646.87	
OM039	IX-B	CHG DEMO CRATERING 40 LB	1.00	5.60	5.60	9.09	286.72	
OM039A	IX-B	CHG DEMO CRATERING 40 LB	1.00	2.00	2.00	2.40	104.00	
OM130	VIII	CAP BLAST SPEC ELEC	96.00	352.00	3.67	4.01	117.96	
OM131	VIII	CAP BLAST NON-ELEC	800.00	161.00	0.20	0.23	5.97	
OM131A	VIII	CAP BLAST NON-ELEC	3600.00	1127.00	0.31	1.22	31.30	
OM131B	VIII	CAP BLAST NON-ELEC	3600.00	0.00	0.00	0.00	0.00	
OM158	I	POWDER ACT TOOL CTG CAL	1000.00	66.67	0.07	0.07	1.33	
OM171	I	POWDER ACT TOOL CTG CAL	1000.00	33.33	0.03	0.04	0.66	
OM172	I	POWDER ACT TOOL CTG CAL	1000.00	33.33	0.03	0.04	0.66	
OM420	IX-B	CHG DEMO SHAPED 15 LB	3.00	12.00	4.00	9.48	280.05	
OM421	IX-B	CHG DEMO SHAPED 40 LB	1.00	12.60	12.60	28.19	889.87	
OM456	I	CORD DET PLIOFILM WRAP	3000.00	2788.00	0.93	3.07	76.95	
OM456A	I	CORD DET PLIOFILM WRAP	4000.00	3718.00	0.93	3.63	108.71	
OM591	IX-B	DYNAMITE MIL (STICK)	100.00	200.00	2.00	3.08	130.26	
OM598	II-J	CRYPTO EQUIP DEST INC TH	22.00	0.00	0.00	0.00	0.01	D
OM599A	II-J	CRYPTO EQUIP DEST INC TH	1.00	0.00	0.00	0.00	0.02	
OM598B	II-J	CRYPTO EQUIP DEST INC TH	1.00	0.00	0.00	0.00	0.09	
OM598C	II-J	CRYPTO EQUIP DEST INC TH	1.00	0.00	0.00	0.00	0.13	
OM626A	I	FIRING DEVICE DEMO M1	150.00	0.03	0.00	0.00	0.02	
OM627	I	FIRING DEV DEMO PRESS-RE	48.00	13.80	0.29	0.34	7.43	
OM627A	I	FIRING DEV DEMO PRESS-RE	200.00	64.20	0.32	0.51	14.76	
OM627B	I	FIRING DEV DEMO PRESS-RE	200.00	0.00	0.00	0.00	0.00	
OM670	I	FUZE BLAST TIME 50-FT	400.00	0.80	0.00	0.00	0.06	
OM670A	I	FUZE BLASTING TIME	200.00	5.37	0.03	0.02	0.44	
OM757	IX-B	CHG ASSY DEMO W/8 M112	2.00	25.07	12.53	22.51	766.62	
OM757A	IX-B	CHG ASSY DEMO W/8 M112	2.00	123.43	61.72	92.57	3517.85	
OM766	I	IGN FUZE BLAST TIME	60.00	336.83	5.61	5.59	163.73	
OM766A	I	IGN FUZE BLAST TIME	300.00	1019.66	3.40	6.80	169.48	
OM814	SPEC	DOCUMENT DESTROYER	1.00	0.00	0.00	0.00	0.01	
OM814A	SPEC	DOCUMENT DESTROYER	1.00	6.40	6.40	18.24	748.90	
OM913	IX-B	CHG DEMO LINEAR HE COMP	1.00	2.16	2.16	159.69	6473.99	
ON285	I	FUZE MT	16.00	2801.52	175.09	198.91	8107.02	
ON285A	I	FUZE MT	1.00	205.25	205.25	15.00	590.10	
ON286A	VI	FUZE MTSQ	1.00	57.60	57.60	4.21	172.80	
ON286D	VI	FUZE MTSQ	1.00	129.60	129.60	9.47	388.80	
ON331A	III	FUZE PD CP .025 SEC DEL	16.00	33.24	2.08	2.16	116.35	
ON340	VI	FUZE PD	16.00	845.10	52.82	60.00	3079.27	
ON340C	VI	FUZE POINT DETONATING PD	1.00	51.84	51.84	3.79	181.44	
ON340E	VI	FUZE PD	1.00	224.64	224.64	16.42	786.24	A
ON340G	VI	FUZE PD	1.00	417.31	417.31	30.51	1460.59	
ON463B	VI	FUZE PROX (VT)	1.00	376.59	376.59	30.50	1482.61	
ON464	SPEC	FUZE PROX (VT)	16.00	228.96	14.31	16.26	748.42	
ON523	III	PRIMER PERC F/M198 & SP'	400.00	4934.15	12.34	13.32	426.80	
ON523A	III	PRIMER PERC F/M198 & SP'	400.00	4495.05	11.24	12.59	367.69	
ON525	III	PRIMER PERC	400.00	5394.05	13.49	14.56	466.58	

TABLE B-5. MAF SUSTAINING RATES FOR CLASS V(W) (Page 4)

MAF 1990 PART 1

EUROPEAN REPLENISHMENT SUSTAINING RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OPA66	X-C	GUIDED MISSILE, SURFACE	8.00	17.14	2.14	121.24	2178.41	AT
OPL23	IV	GUIDED MISSILE & LAUNCHE	1.00	7.20	7.20	59.40	603.60	AT
OVX80	X-C	IMPROVED HAWK MISSILE	1.00	0.02	0.02	3.32	71.39	AA
OVX97	SPEC	STINGER GUIDED MISSLE SY	1.00	0.00	0.00	0.01	0.20	AA
TOTAL						18317.66	986519.38	

*REPLENISHMENT RDS EQUAL (WPNQTY) X (ITEMS/WPNQTY/DAY)

TABLE B-5. MAF SUSTAINING RATES FOR CLASS V(W) (Page 5)

DATE 5 OCT 1983 MAF 1990 PT 2

EUROPEAN REPLENISHMENT SUSTAINING RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
0A011	I	CTG.12-GAGE #00 BUCKSHOT	240.00	150.00	0.63	0.61	25.54	
0A068	I	CTG.5.56MM TRACER	1640.00	1444.48	0.88	0.87	59.08	
0A068A	I	CTG 5.56MM TRACER	1640.00	1055.40	0.64	0.63	42.74	
0A071	I	CTG 5.56MM BALL	1680.00	10130.87	6.03	6.08	429.55	
0A071A	I	CTG 5.56MM BALL	1680.00	14599.64	8.69	8.76	613.18	
0A131	I	CARTRIDGE 7.62 MM	800.00	17040.02	21.30	23.86	1668.22	
0A131B	I	CTG.7.62MM NATO LKD 4BAL	800.00	13636.23	17.05	15.85	1278.40	SA
0A400	I	CTG.CAL.38 SPEC BALL	2400.00	2.32	0.00	0.00	0.10	
0A475	I	CTG.CAL.45 BALL	2000.00	196.08	0.10	0.12	11.24	
0A576	I	CTG.CAL.50 LKD 4 API&1 A	210.00	108.50	0.52	0.65	41.56	
0A576A	I	CTG.CAL.50 LKD 4 API&1 A	200.00	3025.00	15.13	13.61	1134.38	
0B504	II-C	CTG 40MM GRN STAR PARA	44.00	2.02	0.05	0.05	2.20	
0B535	II-C	CTG.40MM WS PARA	44.00	5.08	0.12	0.13	5.53	
0B546	IV	CTG.40MM HE DP	72.00	49.60	0.69	1.07	39.06	
0B567	I	CTG.40MM TACT CS	24.00	15.04	0.63	0.48	17.16	
0C226	IV	CTG.81MM ILLUM	3.00	62.16	20.72	33.84	1225.93	
0C256	IV	CTG.81MM HE	3.00	217.56	72.52	117.72	3916.08	M
0C276	II-D	CTG.81MM SMK WP	3.00	40.40	13.47	23.99	750.28	
0G815A	SPEC	GREN SMK SCREENING (UK)	1.00	2.00	2.00	0.20	10.00	
0G900	II-J	GREN HD INC	16.00	28.42	1.78	1.44	86.15	
0G924	XI-B	GREN HD RIOT CS 1	50.00	1.67	0.03	0.07	1.83	
0G940	II-C	GREN HD SMK GREEN	16.00	34.10	2.13	2.25	95.44	
0G945	II-C	GREN HD SMK YELLOW	16.00	49.26	3.08	3.26	137.86	
0G950	II-C	GREN HD SMK RED	16.00	24.63	1.54	1.63	68.93	
0G963	XI-B	GRENADE,RIOT	16.00	1.60	0.10	0.10	3.30	
0K092A	IV	MINE APERS	4.00	10.00	2.50	1.95	112.50	
0K867	II-E	SMK POT FLOATING HC	12.00	0.07	0.01	0.20	4.01	
0L306	II-C	SIG ILLUM RED STAR CLUST	36.00	2.84	0.08	0.14	4.67	
0L307	II-C	SIG ILLUM WHITE STAR CLU	36.00	7.39	0.21	0.38	12.14	
0L311	II-C	SIG ILLUM RED STAR PARA	36.00	7.39	0.21	0.38	12.14	
0L312	II-C	SIG ILLUM WHITE STAR PAR	36.00	42.06	1.17	2.14	69.13	
0L312F	II-C	SIG ILLUM WHITE STAR PAR	36.00	31.64	0.88	1.24	58.88	D
0L314F	II-C	SIGNAL ILLUMINATION GROU	36.00	8.53	0.24	0.33	15.63	
0L323	II-C	SIG SMK RED PARA	36.00	4.55	0.13	0.23	7.47	
0L324	II-C	SIG SMK GRND GRN PARA	36.00	4.55	0.13	0.23	7.47	
0ML04	SPEC	CUTTER POWDER ACTUATED M	12.00	0.40	0.03	0.03	1.67	
0MX14	IX-B	CONT KIT CAVITY CHGS	1.00	0.03	0.03	0.08	2.20	
0M028A	X-B	DEMO KIT BANG TORP	1.00	0.10	0.10	0.41	19.80	
0M032	IX-B	CHG DEMO BLK 1 LB TNT	48.00	126.00	2.63	4.35	196.87	
0M039A	IX-B	CHG DEMO CRATERING 40 LB	1.00	2.00	2.00	2.40	104.00	
0M130	VIII	CAP BLAST SPEC ELEC	96.00	152.00	1.58	1.73	50.94	
0M130B	VIII	CAP BLAST SPEC ELEC	900.00	10.00	0.01	0.06	1.27	
0M131	VIII	CAP BLAST NON-ELEC	800.00	70.00	0.09	0.10	2.60	
0M131A	VIII	CAP BLAST NON-ELEC	3600.00	122.50	0.03	0.13	3.40	
0M131C	VIII	CAP BLAST NON-ELEC	3600.00	0.07	0.00	0.00	0.00	

TABLE B-5. MAF SUSTAINING RATES FOR CLASS V(W) (Page 6)

DATE 5 OCT 1983 MAF 1990 PT 2

EUROPEAN REPLENISHMENT SUSTAINING RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OM131N	VIII	CAP BLAST NON-ELEC	3600.00	14.00	0.00	0.02	0.39	D
OM168	I	POWDER ACT TOOL CTG CAL.	1000.00	66.67	0.07	0.07	1.33	
OM171	I	POWDER ACT TOOL CTG CAL.	100C.00	33.33	0.03	0.04	0.66	
OM172	I	POWDER ACT TOOL CTG CAL.	1000.00	33.33	0.03	0.04	0.66	
OM174	I	CTG CAL.50 IMPULSE ELEC	154.00	5.60	0.04	0.04	1.82	
OM418	IX-B	CHG DEMO SHAPED	4.00	0.00	0.00	0.00	0.01	
OM420A	IX-B	CHG DEMO SHAPED 15 LB	3.00	0.13	0.04	0.08	2.93	
OM421A	IX-B	CHG DEMO SHAPED 40 LB	1.00	3.67	3.67	6.86	278.67	
OM456	I	CORD DET PLIOFILM WRAP	3000.00	680.00	0.23	0.75	18.77	
OM456A	I	CORD DET PLIOFILM WRAP	4000.00	455.00	0.11	0.44	13.30	
OM456C	I	CORD DET PLIOFILM WRAP	4000.00	150.00	0.04	0.15	4.39	
OM500	I	CUTTER CTG ACT REEFLINE	40.00	96.00	2.40	2.63	87.10	
OM504	I	CUTTER CTG ACT REEFLINE	40.00	96.00	2.40	2.63	104.80	
OM591	IX-B	DYNAMITE MIL (STICK)	100.00	200.00	2.00	3.08	130.26	
OM626A	I	FIRING DEVICE DEMO M1	150.00	0.00	0.00	0.00	0.00	
OM627	I	FIRING DEV DEMO PRESS-RE	48.00	6.30	0.13	0.16	3.39	
OM627A	I	FIRING DEV DEMO PRESS-RE	200.00	7.00	0.03	0.06	1.61	
OM670	I	FUZE BLAST TIME 50-FT	400.00	0.32	0.00	0.00	0.02	
OM670A	I	FUZE BLASTING TIME	200.00	0.60	0.00	0.00	0.10	
OM670C	I	FUZE BLAST TIME 50-FT	200.00	112.00	0.56	0.37	19.59	
OM757	IX-B	CHG ASSY DEMO W/8 M112	2.00	10.67	5.33	9.58	326.22	
OM757A	IX-B	CHG ASSY DEMO W/8 M112	2.00	13.42	6.71	10.06	382.37	
OM757C	IX-B	CHG ASSY DEMO W/8 M112	2.00	0.87	0.43	0.65	24.70	
OM766	I	IGN FUZE BLAST TIME	60.00	143.33	2.39	2.38	69.67	
OM766A	I	IGN FUZE BLAST TIME	300.00	110.83	0.37	0.74	18.46	
OM766C	I	IGN FUZE BLAST TIME	300.00	20.00	0.07	0.13	3.33	
OM862	II-C	SQUIB ELEC DUPONT 1 5 GR	200.00	1.07	0.01	0.01	0.14	
OPA66	X-C	GUIDED MISSILE, SURFACE	8.00	3.81	0.48	26.94	484.09	AT
TOTAL						341.65	14329.21	

*REPLENISHMENT RDS EQUAL (WPNQTY) X (ITEMS/WPNQTY/DAY)

$$AT = \frac{3737}{2,000} \approx 2 \text{ ST}$$

$$AA = \frac{848}{2,000} \approx < 1 \text{ ST}$$

Using Table B-2 again, the sustained LAV requirements are estimated as:

$$LAV(25) = 16.5 \frac{\text{rounds}}{\text{tube}} \times 56 \text{ tubes} \times 0.5 \frac{\text{pounds}}{\text{round}} \times \frac{\text{ST}}{2,000 \text{ lb}} \approx < 1 \text{ ST}$$

$$SA(M60D) = \frac{(107.65 \times 110 \times 0.101)}{2,000} \approx 1 \text{ ST}$$

$$M(HE) = \frac{(38.85 \times 8 \times 17.67)}{2,000} \approx 4 \text{ ST}$$

Class V(A) sustaining rate requirements are calculated by multiplying the intense rate requirement from Table B-4 by an across-the-board planning factor of 80 percent, as indicated in the data package provided by Headquarters Marine Corps. Thus, we have:

$$\begin{aligned} B &= 714 \times 0.8 \approx 57 \text{ ST} \\ MI &= 201 \times 0.8 \approx 161 \text{ ST} \\ R &= 56 \times 0.8 \approx 45 \text{ ST} \\ G &= 39 \times 0.8 \approx 31 \text{ ST} \\ E &= 31 \times 0.8 \approx 25 \text{ ST} \end{aligned}$$

Table B-6 summarizes the MAF sustaining rate requirements.

TABLE B-6. SUSTAINING RATE MAF REQUIREMENTS (SHORT TONS)

Category	Requirement	
Artillery	355	V(W)
Antitank	2	
Demolitions	85	
Mortars	40 (36 + 4)	
Small arms	17 (16 + 1)	
Anti-air missiles	< 1	
Tanks	5	
LAV(25)	< 1	
Bombs	57	V(A)
Missiles	161	
Rockets	45	
Gun ammunition	31	
ECM devices	25	

C. MAB REQUIREMENTS

1. Intense Rate

MAB calculations are performed similarly to the MAF calculations but they use different source data. Table B-7 contains the Class V(W) data (except for the LAV). The computations are:

$$SA = \frac{19982}{2,000} \approx 10 \text{ ST}$$

$$M = \frac{32461}{2,000} \approx 16 \text{ ST}$$

$$T = \frac{7687}{2,000} \approx 4 \text{ ST}$$

$$A = \frac{436073}{2,000} + \frac{105678}{2,000} + \frac{13594}{2,000} = 218 + 53 + 7 \approx 278 \text{ ST}$$

$$D = \frac{54083}{2,000} \approx 27 \text{ ST}$$

TABLE B-7. MAB INTENSE RATES FOR CLASS V(W)

DATE 5 OCT 1983 MAB AE 1990

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OA011	I	CTG.12-GAGE #00 BUCKSHOT	240.00	150.00	0.63	0.61	25.54	SA
OA068	I	CTG.5.56MM TRACER	1640.00	14919.13	9.10	8.95	610.19	
OA068A	I	CTG 5.56MM TRACER	1640.00	2621.39	1.60	1.57	106.17	
OA071	I	CTG 5.56MM BALL	1680.00	104390.31	62.14	62.63	4426.14	
OA071A	I	CTG 5.56MM BALL	1680.00	36699.48	21.84	22.02	1541.38	
OA131	I	CARTRIDGE 7.62 MM	800.00	15654.03	19.57	21.92	1532.53	
OA131B	I	CTG.7.62MM NATO LKD 4BAL	800.00	48594.44	60.74	56.47	4555.73	

TABLE B-7. MAB INTENSE RATES FOR CLASS V(W) (Page 2)

DATE 5 OCT 1983 MAB AE 1990

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
0A136	I	CTG.7.62MM BALL NATO MAT	920.00	630.00	0.68	0.69	52.16	
0A400	I	CTG.CAL.38 SPEC BALL	2400.00	242.25	0.10	0.12	9.96	
0A475	I	CTG.CAL.45 BALL	2000.00	2889.68	1.44	1.73	165.58	
0A576	I	CTG.CAL.50 LKD 4 API&1 A	210.00	194.58	0.93	1.17	74.52	
0A576A	I	CTG.CAL.50 LKD 4 API&1 A	200.00	15133.33	75.67	68.10	5675.00	SA
0B504	II-C	CTG 40MM GRN STAR PARA	44.00	43.98	1.00	1.14	47.90	
0B535	II-C	CTG.40MM WS PARA	44.00	87.27	1.98	2.26	95.03	
0B546	IV	CTG.40MM HE DP	72.00	1046.49	14.53	22.50	824.22	
0B567	I	CTG.40MM TACT CS	24.00	210.00	8.75	6.74	239.65	
0B642	IV	CTG.60MM HE (LWCMS)W/MOF	16.00	865.08	54.07	125.00	6274.07	
0C226	IV	CTG 81MM ILLUM	3.00	276.36	92.12	150.45	5450.41	
0C256	IV	CTG.81MM HE	3.00	966.87	322.29	523.17	17403.60	M
0C276	II-D	CTG.81MM SMK WP	3.00	179.48	59.83	106.56	3333.19	
0C508	IV	CTG.105MM HEAT-T	2.00	45.05	22.52	90.60	3198.55	
0C512	II-D	CTG.105MM SMK WP-T	2.00	10.54	5.27	17.77	754.19	
0C519	II-B	CTG.105MM APERS-T (BEEHI	2.00	10.54	5.27	20.25	772.93	T
0C523	SPEC	CTG.105MM APFSDS-T KE	2.00	44.20	22.10	74.26	2961.40	
0D501	SPEC	PROJ 155MM ADAM	8.00	54.90	6.86	66.57	6052.71	
0D502	SPEC	PROJ 155MM ADAM	8.00	100.50	12.56	121.86	11130.36	
0D503	SPEC	PROJ 155MM RAAMS	8.00	62.10	7.76	75.30	6846.52	
0D505	II-C	PROJ 155MM ILLUM	8.00	215.40	26.92	184.17	21055.34	
0D509	SPEC	PROJ 155MM RAAMS	8.00	91.50	11.44	110.94	10087.86	
0D510	SPEC	PROJ 155MM HE CANNON LCH	6.00	26.40	4.40	140.80	5975.19	
0D532A	SPEC	CHG PROP 155MM RB	1.00	671.11	671.11	731.50	12751.00	
0D533A	II-A	CHG PROP 155MM WB	30.00	891.33	29.71	1185.46	42843.24	
0D540A	II-A	CHG PROP 155MM GB ZONE 2	1.00	712.80	712.80	1546.77	10335.59	
0D541A	II-A	CHG PROP 155MM WB	1.00	133.55	133.55	101.50	4139.98	
0D542	XI-A	PROJ 155MM GAS GB NP	8.00	138.90	17.36	118.76	14428.22	A
0D544	IV	PROJ 155MM HE	8.00	756.90	94.61	647.15	75406.00	
0D550	II-D	PROJ 155MM SMK WP	8.00	114.00	14.25	97.47	11827.49	
0D563	VII	PROJ 155MM HE DP (ICM)	8.00	1293.90	161.74	1568.85	141358.38	
0D579	VII	PROJ 155MM HE RAP	8.00	210.00	26.25	250.70	21787.50	
0D624	SPEC	PROJ 8IN HE RAP	6.00	48.84	8.14	118.84	10199.41	
0D651	V	PROJ 8 IN HE ICM	6.00	262.74	43.79	661.24	56401.46	
0D662	SPEC	CHG PROP 8 IN WB Z 8-9	15.00	51.28	3.42	163.08	4427.33	
0D662A	SPEC	CHG PROP 8 IN WB Z 8-9	1.00	187.31	187.31	258.48	14235.24	
0D675	II-A	CHG PROP 8 IN GB	30.00	80.27	2.68	116.13	3018.30	
0D676A	II-A	CHG PROP 8 IN WB	1.00	262.80	262.80	339.01	13928.48	
0D680	VII	PROJ 8 IN HE	6.00	208.38	34.73	434.12	43516.65	
0D681A	IX-A	FLASH REDUCER F/8 IN	40.00	541.88	13.55	26.71	871.50	
0G815	SPEC	GREN SMK SCREENING (UK)	8.00	102.00	12.75	12.67	442.00	
0G815A	SPEC	GREN SMK SCREENING (UK)	1.00	4.00	4.00	0.40	20.00	
0G900	II-J	GREN HD INC	16.00	37.33	2.33	1.89	113.17	
0G900A	II-J	GRENADE HAND INCENDIARY	16.00	1.07	0.07	0.05	3.13	D
0G924	XI-B	GREN HD RIOT CS 1	50.00	20.00	0.40	0.81	22.00	
0G930	II-E	GREN HD SMK HC	16.00	0.02	0.00	0.00	0.05	

TABLE B-7. MAB INTENSE RATES FOR CLASS V(W) (Page 3)

DATE 5 OCT 1983 MAB AE 1990

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OG930A	II-E	GREN HD SMK HC	16.00	17874.92	1117.18	1005.29	45804 48	
OG937	II-D	GREN HD/RIFLE SMK WP	16.00	64.14	4.01	3.60	167.03	
OG937A	II-D	GRENADE HAND OR RIFLE WP	16.00	0.00	0.00	0.00	0.01	
OG940	II-C	GREN HD SMK GREEN	16.00	77.13	4.82	5.10	215.85	D
OG945	II-C	GREN HD SMK YELLOW	16.00	109.47	6.84	7.24	306.37	
OG950	II-C	GREN HD SMK RED	16.00	59.71	3.73	3.95	167.11	
OG963	XI-B	GRENADE.RIOT	16.00	4.80	0.30	0.29	9 90	
OH55T	SPEC	ROCKET 70MM HE (VIPER)	15.00	32.70	2.18	22.87	311 74	
OH55TA	SPEC	ROCKET 70MM HEAT (VIPER)	15.00	36.65	2.44	25.63	349 40	AT
~~OJ443~~	~~II-B~~	~~RKT MOTOR 5 IN~~	~~1.00~~	~~0.00~~	~~0.00~~	~~3.38~~	~~100.34~~	
OK092A	IV	MINE APERS	4.00	30.00	7.50	5.85	337.50	
OK143A	X-B	MINE AP	6.00	10.00	1.67	3.07	88.33	
OK180A	VII	MINE AT HE HVY	1.00	15.00	15.00	17.55	735.00	
OK867	II-E	SMK POT FLOATING HC	12 00	0.10	0.01	0 30	6 02	
OL306	II-C	SIG ILLUM RED STAR CLUST	36.00	2.94	0.08	0 15	4 84	
OL306A	II-C	SIG ILLUM GRND RED STAR	36 00	3.12	0.09	0.12	5 54	
OL307	II-C	SIG ILLUM WHITE STAR CLU	36.00	17.91	0.50	0.91	29.44	
OL307A	II-C	SIG ILLUM WHITE STAR CLU	1.00	0.00	0.00	0.00	0 00	
OL311	II-C	SIG ILLUM RED STAR PARA	36.00	3.93	0.11	0.20	6.45	
OL311A	II-C	SIG ILLUM RED STAR PARA	36.00	8.43	0.23	0.33	14 99	
OL312	II-C	SIG ILLUM WHITE STAR PAR	36.00	70.90	1.97	3.61	116 52	
OL312A	II-C	SIG ILLUM WHITE STAR PAR	36.00	0.01	0.00	0.00	0.01	
OL312F	II-C	SIG ILLUM WHITE STAR PAR	36.00	14.00	0.39	0.55	26 06	
OL314	II-C	SIG ILLUM GRND GRN STAR	36.00	31.35	0.87	1.60	51.52	
OL314A	II-C	SIG ILLUM GRND GRN SC	36.00	0.00	0.00	0.00	0 00	
OL314F	II-C	SIGNAL ILLUMINATION GROU	36 00	7.66	0.21	0.30	14.04	
OL323	II-C	SIG SMK RED PARA	36.00	3.53	0.10	0.18	5 81	D
OL323A	II-C	SIG SMK GRND RED PARA	36.00	3.67	0.10	0.14	5.60	
OL324	II-C	SIG SMK GRND GRN PARA	36.00	3 73	0.10	0 19	6 13	
OL324A	II-C	SIG SMK GRND GRN PARA	36.00	38.50	1.07	1.51	58.79	
OM028A	X-B	DEMO KIT BANG TORP	1.00	0.20	0.20	0.82	39 60	
OM032	IX-B	CHG DEMO BLK 1 LB TNT	48.00	174.00	3.63	6.00	271.87	
OM039A	IX-B	CHG DEMO CRATERING 40 LB	1.00	3.00	3.00	3.60	156.00	
OM130	VIII	CAP BLAST SPEC ELEC	96.00	110.00	1.15	1.25	36.86	
OM131	VIII	CAP BLAST NON-ELEC	800.00	168.67	0.21	0.24	6.26	
OM131A	VIII	CAP BLAST NON-ELEC	3600.00	463.67	0.13	0.50	12 88	
OM168	I	POWDER ACT TOOL CTG CAL.	1000.00	133.33	0.13	0.15	2 65	
OM171	I	POWDER ACT TOOL CTG CAL.	1000.00	66.67	0.07	0.07	1.33	
OM172	I	POWDER ACT TOOL CTG CAL.	1000.00	33.33	0.03	0.04	0.66	
OM421B	IX-B	CHG DEMO SHAPED 40 LB	1.00	4.13	4 13	0.0	0.0	
OM456	I	CORD DET PLIOFILM WRAP	3000.00	1166.67	0.39	1.28	32.20	
OM456A	I	CORD DET PLIOFILM WRAP	4000.00	1583.33	0.40	1.55	46.30	
OM500	I	CUTTER CTG ACT REEFLINE	40.00	24.00	0.60	0.66	21.78	
OM504	I	CUTTER CTG ACT REEFLINE	40.00	28.00	0.70	0.77	30.57	
OM626A	I	FIRING DEVICE DEMO M1	150.00	11.00	0.07	0.21	5.72	
OM627	I	FIRING DEV DEMO PRESS-RE	48.00	9.20	0.19	0.23	4.95	

TABLE B-7. MAB INTENSE RATES FOR CLASS V(W) (Page 4)

DATE 5 OCT 1983 MAB AE 1990

EUROPEAN REPLENISHMENT INTENSE RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OM627A	I	FIRING DEV DEMO PRESS-RE	200.00	21.40	0.11	0.17	4.92	
OM670	I	FUZE BLAST TIME 50-FT	400.00	366.67	0.92	0.92	26.25	
OM670A	I	FUZE BLASTING TIME	200.00	1799.99	9.00	5.94	314.82	
OM757	IX-B	CHG ASSY DEMO W/B M112	2.00	11.50	5.75	10.33	351.71	
OM757A	IX-B	CHG ASSY DEMO W/B M112	2.00	37.45	18.72	28.09	1067.32	D
OM766	I	IGN FUZE BLAST TIME	60.00	187.07	3.12	3.11	90.93	
OM766A	I	IGN FUZE BLAST TIME	300.00	442.27	1.47	2.95	73.68	
OM913	IX-B	CHG DEMO LINEAR HE COMP	1.00	0.90	0.90	66.60	2700.00	
ON285	I	FUZE MT	16.00	1916.40	119.77	136.06	5545.66	
ON285A	I	FUZE MT	1.00	275.88	275.88	20.17	793.15	
ON286A	VI	FUZE MTSO	1.00	38.00	38.00	2.78	114.00	
ON286D	VI	FUZE MTSO	1.00	85.50	85.50	6.25	256.50	
ON331A	III	FUZE PD CP .025 SEC DEL	16.00	20.84	1.30	1.35	72.93	
ON340	VI	FUZE PD	16.00	567.75	35.48	40.31	2068.76	
ON340C	VI	FUZE POINT DETONATING PD	1.00	34.20	34.20	2.50	119.70	A
ON340E	VI	FUZE PD	1.00	109.20	109.20	7.98	382.20	
ON340G	VI	FUZE PD	1.00	291.69	291.69	21.32	1020.91	
ON463B	VI	FUZE PROX (VT)	1.00	270.42	270.42	21.90	1064.64	
ON464	SPEC	FUZE PROX (VT)	16.00	111.30	6.96	7.90	363.82	
ON523	III	PRIMER PERC F/M198 & SP'	400.00	3679.45	9.20	9.93	318.27	
ON523A	III	PRIMER PERC F/M198 & SP'	400.00	3564.75	8.91	9.98	291.60	
ON525	III	PRIMER PERC	400.00	3564.75	8.91	9.62	308.35	
OPA66	X-C	GUIDED MISSILE, SURFACE	8.00	25.33	3.17	179.18	3219.57	AT
OPL23	IV	GUIDED MISSILE & LAUNCHE	1.00	11.57	11.57	95.44	969.78	
OVX80	X-C	IMPROVED HAWK MISSILE	1.00	11.00	11.00	1660.32	35694.95	
OVX81	X-C	GUIDED MISSILE REDEYE	1.00	0.32	0.32	3.09	34.65	AA
OVX97	SPEC	STINGER GUIDED MISSLE SY	1.00	0.63	0.63	4.14	66.25	
TOTAL						13961.20	710390.75	

*REPLENISHMENT RDS EQUAL (WPNQTY) X (ITEMS/WPNQTY/DAY)

$$AT = \frac{4851}{2,000} \approx 2 \text{ ST}$$

$$AA = \frac{35796}{2,000} \approx 18 \text{ ST}$$

Once again, LAV data are not found in the basic data table (i.e., Table B-7), so the intense rate[1] requirement is estimated using Table B-2, as follows:

$$LAV(25) = 55 \frac{\text{rounds}}{\text{tube}} \times 19 \text{ tubes} \times 0.5 \frac{\text{pounds}}{\text{round}} \times \frac{\text{ST}}{2,000 \text{ lb}} \approx < 1 \text{ ST}$$

$$SA(M60D) = 298.36 \frac{\text{rounds}}{\text{tube}} \times 37 \text{ tubes} \times 0.101 \frac{\text{pounds}}{\text{round}} \times \frac{\text{ST}}{2,000 \text{ lb}} \approx < 1 \text{ ST}$$

$$M(HE) = 49.33 \frac{\text{rounds}}{\text{tube}} \times 3 \text{ tubes} \times 17.67 \frac{\text{pounds}}{\text{round}} \times \frac{\text{ST}}{2,000 \text{ lb}} \approx 1 \text{ ST}$$

Intense rate calculations for Class V(A) are shown in Table B-8. These MAB values are obtained as follows:

$$\text{MAB value} = \text{MAF value} \times \frac{\text{number of aircraft "i" in an MAB}}{\text{number of aircraft "i" in an MAF}}$$

where: "i" represents specific aircraft types (e.g., F4, A6, AH-1, etc.) [Ref. 9].

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[1] Assumes number of LAVs per MAB as approximately one-third of the MAF quantity.

TABLE B-8. CLASS V(A) INTENSE RATE REQUIREMENT (POUNDS)

Aircraft	MAF					MAB/MAF Acft Ratio*	MAB (MAF x MAB/MAF Aircraft Ratio)				
	Bombs	Rockets	Missiles	Gun Ammo	ECM Devices		Bombs	Rockets	Missiles	Gun Ammo	ECM Devices
AV-8	995,010	57,490	321,231	19,874	45,621	0.40	398,004	22,996	128,492	7,950	18,248
F-4/FA-18	102,723	4,523	6,158	566	6,674	0.33	33,899	1,493	2,032	187	2,202
A-6	324,763	1,522	1,340	-	4,585	0.50	162,382	761	670	-	2,293
EA-6	-	-	-	-	908	0.47	-	-	-	-	427
OV-10	-	5,100	-	1,974	316	0.50	-	2,550	-	987	158
CH-53	-	-	-	4,427	1,019	0.38	-	-	-	1,682	387
CH-46	-	-	-	6,395	1,538	0.31	-	-	-	1,983	477
UH-1	-	-	-	5,216	225	0.25	-	-	-	1,304	56
AH-1	4,798	43,696	73,440	39,779	1,627	0.33	1,583	14,420	24,235	13,127	537
						Total Pounds	595,868	42,220	155,432	27,220	24,786
						Total Short Tons	298	21	78	14	12

*MAB/MAF aircraft ratio for a given aircraft type is defined as the number of that type aircraft in a MAB divided by the number of that same aircraft type in a MAF.

Table B-9 summarizes the Class V(W) and V(A) MAB intense rate requirements.

TABLE B-9. INTENSE RATE MAB REQUIREMENTS (SHORT TONS)

Category	Requirement	
Artillery	278	V(W)
Demolitions	27	V(W)
Anti-air missiles	18	V(W)
Mortars	17 (16 + 1)	V(W)
Small arms	10	V(W)
Tanks	4	V(W)
Antitank	2	V(W)
LAV(25)	< 1	V(W)
Bombs	298	V(A)
Missiles	78	V(A)
Rockets	21	V(A)
Gun ammunition	14	V(A)
ECM devices	12	V(A)

2. Sustaining Rate

For the sustaining rate, the corresponding calculations (using the data of Table B-10) are:

$$SA = \frac{9341}{2,000} \approx 5 \text{ ST}$$

$$M = \frac{24888}{2,000} \approx 12 \text{ ST}$$

$$T = \frac{2585}{2,000} \approx 1 \text{ ST}$$

$$A = \frac{178124}{2,000} + \frac{39584}{2,000} + \frac{5616}{2,000} = 89 + 20 + 3 \approx 112 \text{ ST}$$

$$D = \frac{44814}{2,000} \approx 22 \text{ ST}$$

$$AT = \frac{1175}{2,000} \approx 1 \text{ ST}$$

TABLE B-10. MAB SUSTAINING RATES FOR CLASS V(W)

DATE 5 OCT 1983 MAB AE 1990

EUROPEAN REPLENISHMENT SUSTAINING RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
0A011	I	CTG.12-GAGE #00 BUCKSHOT	240.00	150.00	0.63	0.61	25.54	SA
0A068	I	CTG.5.56MM TRACER	1640.00	6494.21	3.96	3.90	265.61	SA
0A068A	I	CTG 5.56MM TRACER	1640.00	1156.50	0.71	0.69	46.84	SA
0A071	I	CTG 5.56MM BALL	1680.00	45547.36	27.11	27.33	1931.21	SA
0A071A	I	CTG 5.56MM BALL	1680.00	15998.21	9.52	9.60	671.92	SA
0A131	I	CARTRIDGE 7.62 MM	800.00	8680.76	10.85	12.15	849.85	SA
0A131B	I	CTG.7.62MM NATO LKD 4BAL	800.00	24654.31	30.82	28.65	2311.34	SA
0A136	I	CTG.7.62MM BALL NATO MAT	920.00	630.00	0.68	0.69	52.16	SA
0A400	I	CTG.CAL.38 SPEC BALL	2400.00	187.34	0.08	0.09	7.70	SA
0A475	I	CTG.CAL.45 BALL	2000.00	315.24	0.16	0.19	18.06	SA
0A576	I	CTG.CAL.50 LKD 4 API&I A	210.00	108.50	0.52	0.65	41.56	SA
0A576A	I	CTG.CAL.50 LKD 4 API&I A	200.00	5675.00	28.38	25.54	2128.13	SA
0B504	II-C	CTG 40MM GRN STAR PARA	44.00	22.05	0.50	0.57	24.01	SA
0B535	II-C	CTG.40MM WS PARA	44.00	55.53	1.26	1.44	60.48	SA
0B546	IV	CTG.40MM HE DP	72.00	542.50	7.53	11.66	427.27	SA
0B567	I	CTG.40MM TACT CS	24.00	164.50	6.85	5.28	187.73	SA
0B642	IV	CTG.60MM HE (LWCNS)W/MOF	16.00	588.06	36.75	84.97	4204.56	M
0C226	IV	CTG.81MM ILLUM	3.00	217.56	72.52	118.44	4290.75	M
0C256	IV	CTG.81MM HE	3.00	761.46	253.82	412.03	13706.27	M
0C276	II-D	CTG.81MM SMK WP	3.00	141.40	47.13	83.95	2625.99	M
0C508	IV	CTG.105MM HEAT-T	2.00	15.13	7.56	30.43	1074.[illegible]	T
0C512	II-D	CTG.105MM SMK WP-T	2.00	3.57	1.78	6.02	255.45	T
0C519	II-B	CTG.105MM APERS-T (BEEH)	2.00	3.57	1.78	6.86	261.80	T
0C523	SPEC	CTG.105MM APFSDS-T KE	2.00	14.82	7.41	24.90	993.21	T
0D501	SPEC	PROJ 155MM ADAM	8.00	40.20	5.02	48.74	[illegible]	A
0D502	SPEC	PROJ 155MM ADAM	8.00	18.30	2.29	22.19	2025.72	A
0D503	SPEC	PROJ 155MM RAAMS	8.00	29.10	3.64	35.28	3208.27	A
0D505	II-C	PROJ 155MM ILLUM	8.00	111.60	13.95	95.42	10908.89	A
0D509	SPEC	PROJ 155MM RAAMS	8.00	18.90	2.36	22.92	2083.72	A
0D510	SPEC	PROJ 155MM HE CANNON LCH	6.00	9.00	1.50	48.00	2037.00	A
0D532A	SPEC	CHG PROP 155MM RB	1.00	231.34	231.34	252.16	4395.44	A
0D533A	II-A	CHG PROP 155MM WB	30.00	303.63	10.12	403.83	14594.68	A
0D540A	II-A	CHG PROP 155MM GB ZONE 2	1.00	287.04	287.04	622.88	4162.07	A
0D541A	II-A	CHG PROP 155MM WB	1.00	69.19	69.19	52.59	2144.95	A
0D542	XI-A	PROJ 155MM GAS GB NP	8.00	55.20	6.90	47.20	5733.89	A
0D544	IV	PROJ 155MM HE	8.00	312.90	39.11	267.53	31172.62	A
0D550	II-D	PROJ 155MM SMK WP	8.00	48.00	6.00	41.04	4980.00	A
0D563	VII	PROJ 155MM HE DP (ICM)	8.00	502.20	62.77	608.92	54865.31	A
0D579	VII	PROJ 155MM HE RAP	8.00	120.00	15.00	143.26	12450.00	A
0D624	SPEC	PROJ 8IN HE RAP	6.00	18.96	3.16	46.14	3959.48	A
0D651	V	PROJ 8 IN HE ICM	6.00	97.74	16.29	245.98	20981.51	A
0D662	SPEC	CHG PROP 8 IN WB Z 8-9	15.00	19.91	1.33	63.31	1718.72	A
0D662A	SPEC	CHG PROP 8 IN WB Z 8-9	1.00	75.61	75.61	104.35	5746.66	A
0D675	II-A	CHG PROP 8 IN GB	30.00	32.41	1.08	46.88	1218.46	A
0D676A	II-A	CHG PROP 8 IN WB	1.00	105.70	105.70	136.36	5602.26	A

TABLE B-10. MAB SUSTAINING RATES FOR CLASS V(W) (Page 2)

DATE 5 OCT 1983 MAB AE 1990

EUROPEAN REPLENISHMENT SUSTAINING RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
0D680	VII	PROJ 8 IN HE	6.00	92.34	15.39	192.37	19283.66	
0D681A	IX-A	FLASH REDUCER F/8 IN	40.00	217.93	5.45	10.74	350.50	A
0G815	SPEC	GREN SMK SCREENING (UK)	8.00	51.00	6.38	6.33	221.00	
0G815A	SPEC	GREN SMK SCREENING (UK)	1.00	2.00	2.00	0.20	10.00	
0G900	II-J	GREN HD INC	16.00	37.33	2.33	1.89	113.17	
0G900A	II-J	GRENADE HAND INCEND'ARY	16.00	1.07	0.07	0.05	3.13	
0G924	XI-B	GREN HD RIOT CS 1	50.00	20.00	0.40	0.81	22.00	
0G930	II-E	GREN HD SMK HC	16.00	0.02	0.00	0.00	0.05	D
0G930A	II-E	GREN HD SMK HC	16.00	15399.95	962.50	866.09	39462.37	
0G937	II-D	GREN HD/RIFLE SMK WP	16.00	33.60	2.10	1.88	87.49	
0G937A	II-D	GRENADE HAND OR RIFLE WP	16.00	0.00	0.00	0.00	0.00	
0G940	II-C	GREN HD SMK GREEN	16.00	44.78	2.80	2.96	125.33	
0G945	II-C	GREN HD SMK YELLOW	16.00	64.69	4.04	4.28	181.03	
0G950	II-C	GREN HD SMK RED	16.00	32.34	2.02	2.14	90.52	
0G963	XI-B	GRENADE,RIOT	16.00	4.80	0.30	0.29	9.90	
0H557	SPEC	ROCKET 70MM HE (VIPER)	15.00	7.32	0.49	5.12	69.78	
0H557A	SPEC	ROCKET 70MM HEAT (VIPER)	15.00	9.16	0.61	6.41	87.35	AT
~~[illegible]~~	~~II-B~~	~~RKT MOTOR 5 IN~~	~~1.00~~	~~0.50~~	~~0.50~~	~~4.03~~	~~105.26~~	
0K092A	IV	MINE APERS	4.00	10.00	2.50	1.95	112.50	
0K143A	X-B	MINE AP	6.00	5.00	0.83	1.53	44.16	
0K180A	VII	MINE AT HE HVY	1.00	5.00	5.00	5.85	245.00	
0K867	II-E	SMK POT FLOATING HC	12.00	0.07	0.01	0.20	4.01	
0L306	II-C	SIG ILLUM RED STAR CLUST	36.00	0.98	0.03	0.05	1.61	
0L306A	II-C	SIG ILLUM GRND RED STAR	36.00	1.10	0.03	0.04	1.96	
0L307	II-C	SIG ILLUM WHITE STAR CLU	36.00	9.70	0.27	0.49	15.95	
0L307A	II-C	SIG ILLUM WHITE STAR CLU	1.00	0.00	0.00	0.00	0.00	
0L311	II-C	SIG ILLUM RED STAR PARA	36.00	2.55	0.07	0.13	4.19	
0L311A	II-C	SIG ILLUM RED STAR PARA	36.00	5.32	0.15	0.21	9.45	
0L312	II-C	SIG ILLUM WHITE STAR PAR	36.00	55.23	1.53	2.81	90.76	
0L312A	II-C	SIG ILLUM WHITE STAR PAR	36.00	0.01	0.00	0.00	0.01	
0L312F	II-C	SIG ILLUM WHITE STAR PAR	36.00	10.93	0.30	0.43	20.34	
0L314	II-C	SIG ILLUM GRND GRN STAR	36.00	21.45	0.60	1.09	35.25	
0L314A	II-C	SIG ILLUM GRND GRN SC	36.00	0.00	0.00	0.00	0.00	D
0L314F	II-C	SIGNAL ILLUMINATION GROU	36.00	2.94	0.08	0.12	5.40	
0L323	II-C	SIG SMK RED PARA	36.00	1.57	0.04	0.08	2.58	
0L323A	II-C	SIG SMK GRND RED PARA	36.00	1.65	0.05	0.06	2.52	
0L324	II-C	SIG SMK GRND GRN PARA	36.00	1.57	0.04	0.08	2.58	
0L324A	II-C	SIG SMK GRND GRN PARA	36.00	1.65	0.05	0.06	2.52	
0M028A	X-B	DEMO KIT BANG TORP	1.00	0.10	0.10	0.41	19.80	
0M032	IX-B	CHG DEMO BLK 1 LB TNT	48.00	174.00	3.63	6.00	271.87	
0M039A	IX-B	CHG DEMO CRATERING 40 LB	1.00	2.00	2.00	2.40	104.00	
0M130	VIII	CAP BLAST SPEC ELEC	96.00	176.00	1.83	2.01	58.98	
0M131	VIII	CAP BLAST NON-ELEC	800.00	80.50	0.10	0.11	2.20	
0M131A	VIII	CAP BLAST NON-ELEC	3600.00	374.50	0.10	0.41	10.40	
0M168	I	POWDER ACT TOOL CTG CAL.	1000.00	66.67	0.07	0.07	1.33	
0M171	I	POWDER ACT TOOL CTG CAL.	1000.00	33.33	0.03	0.04	0.66	

TABLE B-10. MAB SUSTAINING RATES FOR CLASS V(W) (Page 3)

DATE 5 OCT 1983 MAB AE 1990

EUROPEAN REPLENISHMENT SUSTAINING RATE (PER DAY) OF CLASS VW FOR MAGTF

DODIC	CG CLASS	DESCRIPTION	ROUNDS PER PACKAGE ROUNDS	ROUNDS	PACKAGES	CU FT	POUNDS	
OM172	I	POWDER ACT TOOL CTG CAL.	1000.00	33.33	0.03	0.04	0.66	
OM421B	IX-B	CHG DEMO SHAPED 40 LB	1.00	4.20	4.20	0.0	0.0	
OM456	I	CORD DET PLIOFILM WRAP	3000.00	1190.00	0.40	1.31	32.84	
OM456A	I	CORD DET PLIOFILM WRAP	4000.00	1235.00	0.31	1.21	36.11	
OM500	I	CUTTER CTG ACT REEFLINE	40.00	32.00	0.80	0.88	29.03	
OM504	I	CUTTER CTG ACT REEFLINE	40.00	32.00	0.80	0.88	34.93	
OM591A	IX-B	DYNAMITE MIL (STICK)	1.00	200.00	200.00	2.50	100.00	
OM626A	I	FIRING DEVICE DEMO MI	150.00	0.01	0.00	0.00	0 01	D
OM627	I	FIRING DEV DEMO PRESS-RE	48.00	6.90	0 14	0.17	3 71	
OM627A	I	FIRING DEV DEMO PRESS-RE	200 00	21.40	0.11	0.17	4 92	
OM670	I	FUZE BLAST TIME 50-FT	400 00	0.37	0.00	0 00	0 03	
OM670A	I	FUZE BLASTING TIME	200 00	1.80	0.01	0 01	0.31	
OM757	IX-B	CHG ASSY DEMO W/8 M112	2.00	12.27	6 13	11 01	375 15	
OM757A	IX-B	CHG ASSY DEMO W/8 M112	2.00	41.02	20.51	30 76	1168 97	
OM766	I	IGN FUZE BLAST TIME	60.00	164.83	2.75	2 74	80 13	
OM766A	I	IGN FUZE BLAST TIME	300 00	338.83	1 13	2 26	56 45	
OM913	IX-B	CHG DEMO LINEAR HE COMP	1 00	0.50	0.50	36 85	1494.00	
ON285	I	FUZE MT	16.00	778.20	48.64	55 25	2251 95	
ON285A	I	FUZE MT	1 00	102.63	102.63	7.50	295.05	
ON286A	VI	FUZE MTSQ	1.00	16.00	16.00	1.17	48 00	
ON286D	VI	FUZE MTSQ	1.00	36.00	36.00	2 63	108.00	
ON331A	III	FUZE PD CP .025 SEC DEL	16.00	9.23	0.58	0.60	32 32	
ON340	VI	FUZE PD	16 00	234.75	14.67	16 67	855 38	
ON340C	VI	FUZE POINT DETONATING PD	1 00	14.40	14.40	1 05	50.40	A
ON340E	VI	FUZE PD	1.00	62.40	62 40	4 56	218 40	
ON340G	VI	FUZE PD	1.00	115.92	115 92	8 47	405 72	
ON463B	VI	FUZE PROX (VT)	1.00	104.61	104 61	8 47	411.84	
ON464	SPEC	FUZE PROX (VT)	16.00	63.60	3.97	4.52	207 90	
ON523	III	PRIMER PERC F/M198 & SP'	400.00	1480.25	3.70	4.00	128 04	
ON523A	III	PRIMER PERC F/M198 & SP'	400.00	1498.35	3.75	4.20	122 56	
ON525	III	PRIMER PERC	400.00	1498.35	3.75	4.05	129.61	
OPA66	X-C	GUIDED MISSILE, SURFACE	8.00	6.43	0.80	45 46	816 90	AT
OPL23	IV	GUIDED MISSILE & LAUNCHE	1.00	2.40	2.40	19 80	201 20	
OVX80	X-C	IMPROVED HAWK MISSILE	1.00	0.01	0.01	1.66	35.69	
OVX81	X-C	GUIDED MISSILE REDEYE	1.00	0.05	0.05	0 46	5 14	AA
OVX97	SPEC	STINGER GUIDED MISSLE SY	1.00	0.00	0.00	0.00	0 07	
TOTAL						5664 98	305976 75	

*REPLENISHMENT RDS EQUAL (WPNQTY) X (ITEMS/WPNQTY/DAY)

$$AA = \frac{41}{2,000} \approx < 1 \text{ ST}$$

Using Table B-2 again, the sustained LAV requirements are estimated as:

$$LAV(25) = 16.5 \frac{\text{rounds}}{\text{tube}} \times 19 \text{ tubes} \times 0.5 \frac{\text{pounds}}{\text{round}} \times \frac{\text{ST}}{2,000 \text{ lb}} \approx < 1 \text{ ST}$$

$$SA(M60D) = \frac{(107.65 \times 37 \times 0.101)}{2,000} \approx < 1 \text{ ST}$$

$$M(HE) = \frac{(38.85 \times 3 \times 17.67)}{2,000} \approx 1 \text{ ST}$$

The Class V(A) sustaining rate requirements are again 80 percent of the intense rate, hence:

$$B = 298 \times 0.8 \approx 238 \text{ ST}$$
$$MI = 78 \times 0.8 \approx 62 \text{ ST}$$
$$R = 21 \times 0.8 \approx 17 \text{ ST}$$
$$G = 14 \times 0.8 \approx 11 \text{ ST}$$
$$E = 12 \times 0.8 \approx 10 \text{ ST}$$

Table B-11 summarizes the MAB sustaining rate requirements.

TABLE B-11. SUSTAINING RATE MAB REQUIREMENTS (SHORT TONS)

Category	Requirement	
Artillery	112	V(W)
Demolitions	22	V(W)
Mortars	13 (12 + 1)	V(W)
Small arms	5	V(W)
Tanks	1	V(W)
Antitank	1	V(W)
Anti-air missiles	< 1	V(W)
LAV(25)	< 1	V(W)
Bombs	238	V(A)
Missiles	62	V(A)
Rockets	17	V(A)
Gun ammunition	11	V(A)
ECM devices	10	V(A)

Appendix C

COMPUTATION OF CONTAINER EQUIVALENT UNITS

A. GENERAL APPROACH

This appendix describes the calculation of CEUs for the following general categories of ammunition:

- Class V(W)
  - -- Small arms (SA)
  - -- Mortars (M)
  - -- Tanks (T)
  - -- Artillery (A)
  - -- Demolitions (D)
  - -- Antitank (AT)
  - -- Anti-air missiles (AA)
  - -- Light-armored vehicles (LAV).
- Class V(A)
  - -- Bombs (B)
  - -- Missiles (MI)
  - -- Rockets (R)
  - -- Gun ammunition (G)
  - -- ECM devices (E).

The procedure used to compute CEUs for each ammunition category is dependent on the comparison of that category's density to the critical density[1] of an 8'x8'x20' container, which is 37.1 lb/ft^3. If the category density is greater than or equal to 37.1 lb/ft^3, the container tends to "weigh out" before "cubing out" so the following procedures are used:

---

[1]Critical density is defined in Reference 11 as that density that would simultaneously cause a container to be loaded to its maximum weight and cube capacity. For an 8'x8'x20' container, the critical density is 37.1 lb/ft^3.

Procedure 1 - Category Density $\geq$ Critical Density (37.1 lb/ft^3)

$$CEU_i = \frac{ST_i}{19}$$

where: CEU_i = the number of CEUs of ammunition in category "i"

ST_i = short tons of ammunition in category "i" from the appropriate table in Appendix B

19 = the average number of short tons of ammunition per 8'x8'x20' container.

If a category density is less than 37.1 lb/ft^3, the container "cubes out" first and the following procedure (Procedure 2) is used in place of Procedure 1.

Procedure 2 - Category Density < Critical Density (37.1 lb/ft^3)

$$CEU_i = ST_i \times 2000 \ \frac{lb}{ST} \times \frac{1}{D_i} \ \frac{ft^3}{lb} \times \frac{1}{666} \ \frac{CEU}{ft^3}$$

which simplifies to:

$$CEU_i = \frac{ST_i}{D_i} \times 3$$

where: CEU_i = the number of CEUs of ammunition in category "i"

ST_i = short tons of ammunition in category "i" from the appropriate table in Appendix B

D_i = the estimated density (in lb/ft^3) of ammunition in category "i."

Determination of D_i, the estimated category density, is discussed in the following paragraphs.

B. ESTIMATING CATEGORY DENSITIES (D_i's)

Category densities are expressed in pounds per cubic foot and are calculated by dividing the total weight for a given category by the total cube for that same category. The weight and cube data used in these computations are found in Table B-1. The notation D_i is used to denote the density of ammunition in category "i." The values of "i" for specific ammunition categories are shown in Table C-1.

TABLE C-1. "i" VALUES FOR AMMUNITION CATEGORIES

Category	"i" Value
Small arms	SA
Mortars	M
Tanks	T
Artillery	A
Demolitions	D
Antitank	AT
Anti-air missiles	AA
Light-armored vehicle	LAV
Bombs	B
Missiles	MI
Rockets	R
Gun ammunition	G
ECM devices	E

Hence, D_{SA} indicates the estimated density of small arms, D_M is the estimated density of mortars, and so on. The actual calculations are shown below for each category in Table C-1.

$$D_{SA} = \frac{71448}{1001} \approx 71.4 \frac{\text{lb}}{\text{ft}^3}$$

$$D_M = \frac{93643}{2604} \approx 36.0$$

$$D_T = \frac{31653}{835} \approx 37.9$$

$$\left.\begin{aligned} D_{A_{Proj}} &= \frac{1402332}{14675} \approx 58.5 \\ D_{A_{Prop}} &= \frac{315819}{14149} \approx 2.3 \\ D_{A_{Fuze}} &= \frac{46008}{1085} \approx 42.4 \end{aligned}\right\} *$$

$$D_D = \frac{209356}{4760} \approx 44.0$$

$$D_{AT} = \frac{15385}{1016} \approx 15.1$$

$$D_{AA} = \frac{71589}{3333} \approx 21.5$$

$$D_{LAV} = \frac{1540}{52} \approx 29.4$$

$$D_B = \frac{1427302}{41324} \approx 34.5$$

$$D_R = \frac{112330}{3739} \approx 30.0$$

$$D_{MI} = \frac{402169}{22687} \approx 17.7$$

$$D_G = \frac{78228}{1337} \approx 58.5$$

---

*Three separate densities are used for artillery because of the large density differences in projectiles, propellants, and fuzes.

$$D_E = \frac{62508}{2490} \approx 25.1$$

As explained previously, the procedure used to calculate the CEU for a given category depends on whether the estimate density for that category is greater or less than the critical density of 37.1 lb/ft^3. Procedure 1 is used when the estimated category density is greater than or equal to this critical density. Procedure 2 is used when the category density is less than the critical density. Actual CEU calculations for the different ammunition categories are shown in the following sections.

C. MAF CEUs

To compute the CEUs for a MAF at the intense rate, we use the intense rate STs from Table B-4 and the appropriate procedure (i.e., Procedure 1 or 2), as shown below:

$$CEU_{SA} = \frac{38\ (ST)}{19\ \frac{ST}{CEU}} \approx 2$$

$$CEU_M = \frac{52}{36} \times 3 \approx 4.3$$

$$CEU_T = \frac{16}{19} \approx 0.8 \ ^*$$

---

*For the M1 tank, the equivalent calculation is $CEU_{T(M1)} = \frac{18}{19} = 0.9$. There is essentially no difference in the CEU requirement for the M60 and M1 tanks.

$$CEU_A = \frac{701}{19} + \frac{158}{22.3} \times 3 + \frac{23}{19} \approx 59.4\ ^{*}$$

$$CEU_D = \frac{105}{19} \approx 5.5$$

$$CEU_{AT} = \frac{8}{15} \times 3 \approx 1.6$$

$$CEU_{AA} = \frac{36}{22} \times 3 \approx 4.9$$

$$CEU_{LAV} = \frac{1}{29} \times 3 \approx 0.1$$

$$CEU_B = \frac{714}{35} \times 3 \approx 61.2$$

$$CEU_R = \frac{56}{30} \times 3 \approx 5.6$$

$$CEU_{MI} = \frac{201}{18} \times 3 \approx 33.5$$

$$CEU_G = \frac{39}{19} \approx 2.1$$

$$CEU_E = \frac{31}{25} \times 3 \approx 3.7$$

---

*The artillery CEUs are the sum of the projectile CEUs (first term), plus the propellant CEUs (second term), plus the fuze/primer CEUs (last term).

For a MAF at the sustaining rate, we use the STs from Table B-6 and obtain the following results:

$$CEU_{SA} = \frac{17}{19} \approx 0.9$$

$$CEU_{M} = \frac{40}{36} \times 3 \approx 3.3$$

$$CEU_{T} = \frac{5}{19} \approx 0.3$$

$$CEU_{A} = \frac{287}{19} + \frac{58}{22.3} \times 3 + \frac{10}{19} \approx 23.4 \ *$$

$$CEU_{D} = \frac{85}{19} \approx 4.5$$

$$CEU_{AT} = \frac{2}{15} \times 3 \approx 0.4$$

$$CEU_{AA} = \frac{< 1}{22} \times 3 \approx < 0.1$$

$$CEU_{LAV} = \frac{< 1}{29} \times 3 \approx < 0.1$$

$$CEU_{B} = \frac{571}{35} \times 3 \approx 48.9$$

---

*The artillery CEUs are the sum of the projectile CEUs, propellant CEUs, and fuze/primer CEUs.

$$CEU_R = \frac{45}{30} \times 3 \approx 4.5$$

$$CEU_{MI} = \frac{161}{18} \times 3 \approx 26.8$$

$$CEU_G = \frac{31}{19} \approx 1.6$$

$$CEU_E = \frac{25}{25} \times 3 \approx 3.0$$

D. MAB CEUs

The approach for calculating MAB CEUs is identical to that used for the MAF except that the intense rate STs come from Table B-9. At the intense rate the calculations are:

$$CEU_{SA} = \frac{10}{19} \approx 0.5$$

$$CEU_M = \frac{17}{36} \times 3 \approx 1.4$$

$$CEU_T = \frac{4}{19} \approx 0.2$$

$$CEU_A = \frac{218}{19} + \frac{53}{22.3} \times 3 + \frac{7}{19} \approx 19^{*}$$

---

*The artillery CEUs are the sum of the projectile CEUs, propellant CEUs, and fuze/primer CEUs.

$$CEU_D = \frac{27}{19} \approx 1.4$$

$$CEU_{AT} = \frac{2}{15} \times 3 \approx 0.4$$

$$CEU_{AA} = \frac{18}{22} \times 3 \approx 2.5$$

$$CEU_{LAV} = \frac{< 1}{29} \times 3 \approx 0.1$$

$$CEU_B = \frac{298}{35} \times 3 \approx 25.5$$

$$CEU_R = \frac{21}{30} \times 3 \approx 2.1$$

$$CEU_{MI} = \frac{78}{18} \times 3 \approx 13.0$$

$$CEU_G = \frac{14}{19} \approx 0.7$$

$$CEU_E = \frac{12}{25} \times 3 \approx 1.4$$

At the sustaining rate, the STs come from Table B-11 and the computations are:

$$CEU_{SA} = \frac{5}{19} \approx 0.3$$

$$CEU_M = \frac{13}{36} \times 3 \approx 1.1$$

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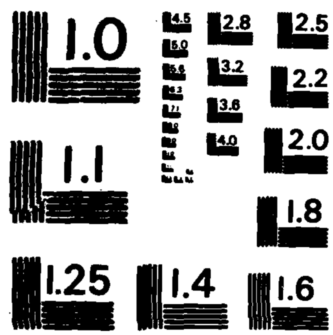

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$$CEU_T = \frac{1}{19} \approx 0.1$$

$$CEU_A = \frac{89}{19} + \frac{20}{22.3} \times 3 + \frac{3}{19} \approx 7.6^{*}$$

$$CEU_D = \frac{22}{19} \approx 1.2$$

$$CEU_{AT} = \frac{1}{15} \times 3 \approx 0.2$$

$$CEU_{AA} = \frac{< 1}{22} \times 3 \approx < 0.1$$

$$CEU_{LAV} = \frac{< 1}{29} \times 3 \approx < 0.1$$

$$CEU_B = \frac{238}{35} \times 3 \approx 20.4$$

$$CEU_R = \frac{17}{30} \times 3 \approx 1.7$$

$$CEU_{MI} = \frac{62}{18} \times 3 \approx 10.3$$

$$CEU_G = \frac{11}{19} \approx 0.6$$

$$CEU_E = \frac{10}{25} \times 3 \approx 1.2$$

---

*The artillery CEUs are the sum of the projectile CEUs, propellant CEUs, and fuze/primer CEUs.

Appendix D

TIME PHASING AND GEOGRAPHICAL DISTRIBUTION OF CLASS V(A) MAF CEUs

To take into account the time phasing ashore of aviation units, the daily CEU requirements can be applied only during the days when a particular base is operational. For purposes of this study, the assumed operational times shown in Table D-1 were used.

TABLE D-1. AIR BASE OPERATIONAL TIME FRAMES

Facility	Assumed Operational Time Frame
Forward Base 1	D+5
Main Base 1	D+8
Main Base 2	D+12
SELF	D+30

To arrive at the geographical distribution of Class V(A) CEUs, the study team began with the short-ton distribution of the MAF ACE bed-down that was provided by Headquarters, Marine Corps. This distribution is shown in Table D-2.

TABLE D-2. GEOGRAPHICAL DISTRIBUTION OF CLASS V(A) REQUIREMENTS

Facility	Short Tons per Day (Intense Rate)					
	Bombs	Rockets	Missiles	Gun Ammo	ECM Devices	Total
Main Base 1	107.7	8.8	14.1	10.6	3.9	145.1
Main Base 2	107.7	8.8	14.1	9.2	3.7	143.5
Forward Base 1	99.9	9.4	38.2	5.3	4.7	157.5
Forward Base 2	99.9	9.4	38.2	5.3	4.7	157.5
SELF	298.5	19.8	96.4	8.7	14.3	437.7
Total	713.7	56.2	201.0	39.1	31.3	1,041.3

To convert these values to CEUs at the intense rate, one of the two procedures detailed in Appendix C was applied to Table D-2 based on the comparison of each category density to the critical density of 37.1 lb/ft^3. The resulting daily CEU totals are shown in Table D-3.

TABLE D-3. GEOGRAPHICAL DISTRIBUTION OF CLASS V(A) CEUs AT INTENSE RATE

Facility	CEUs per Day (Intense Rate)					
	Bombs	Rockets	Missiles	Gun Ammo	ECM Devices	Total
Main Base 1	9.2	0.9	2.3	0.6	0.4	13.4
Main Base 2	9.2	0.9	2.3	0.5	0.4	13.3
Forward Base 1	8.6	0.9	6.4	0.3	0.6	16.8
Forward Base 2	8.6	0.9	6.4	0.3	0.6	16.8
SELF	25.6	2.0	16.1	0.4	1.7	45.8
Total	61.2	5.6	33.5	2.1	3.7	106.1

Since ACE bed-down data were provided by the Marine Corps only for the intense rate, the study team assumed the sustained rate values to be 80 percent of the intense values. Taking 80 percent of each value in Table D-3 yields the CEU per day requirement at the sustained rates, as shown in Table D-4.

TABLE D-4. GEOGRAPHICAL DISTRIBUTION OF CLASS V(A) CEUs AT SUSTAINED RATE

Facility	CEUs per Day (Sustained Rate)					
	Bombs	Rockets	Missiles	Gun Ammo	ECM Devices	Total
Main Base 1	7.4	0.7	1.8	0.5	0.3	10.7
Main Base 2	7.4	0.7	1.8	0.4	0.3	10.6
Forward Base 1	6.9	0.7	5.1	0.2	0.5	13.4
Forward Base 2	6.9	0.7	5.1	0.2	0.5	13.4
SELF	20.4	1.6	12.8	0.3	1.4	36.5
Total*	49.0	4.4	26.6	1.6	3.0	84.6

*Totals vary slightly with Appendix C due to rounding.

Appendix E

PRODUCTIVITY PLANNING FACTORS (20-HOUR WORKDAY)

A. BEACH TRANSFER

1. LACH Operations [Ref. 14]

- Daily production (combination of incoming and retrograde): 120 cpd per LACH.
- Average time per lift for container handling from lighter to transporter: 10 minutes.

2. ELCAS Operations

- Daily production (combination of incoming and retrograde): 300 cpd per ELCAS [Ref. 14].
- Average time on elevated causeway (based on Reference 15).

Queue and movement	18
Loading time	4
Secure load and depart	8
	30 minutes

3. Allocation of Resources (MAF) [Ref. 7]

LACH	12
ELCAS	2

4. Container Throughput [Ref. 14]

- Theoretical maximum (based on total numbers of beach discharge equipment):

LACH	12 x 120 =	1,440
ELCAS	2 X 300 =	600
		2,040 cpd

- Operational maximum (based on allocation of three crane ships per MAF):

  3 x 225 cpd per ship (at sea state zero) = 675 cpd

B. MATERIALS HANDLING EQUIPMENT

The work cycle figures presented below for the RTCH and the 4K RTFL represent average production for typical tasks in an AOA relative to container handling and unstuffing. To provide for a reasonable degree of realism, incorporated into these figures and into all calculations are an operational efficiency factor of 0.83 and a work delay factor of 1.26 [Ref. 27]. The latter accounts for the delaying effects of workload, site area, labor quality, supervision, job conditions, weather, maintenance, and the tactical/logistical situation. These factors (1.26/183 = 1.52) are reflected in the "adjusted cycle time" presented in each case.

1. RTCH Operations (Based on Reference 27)

These productivity figures are based on the premise that operations are performed on suitable stable surfaces or that techniques are employed to preclude the RTCH getting mired down due to multiple passes over unimproved soil.

a. Offload Transporter and Move Container to Marshaling Area

(1) Cycle Times (minutes)

Attach and detach	1.6
Travel	1.0
Maneuver	1.0
	3.6

(2) Adjusted Cycle Time

5.5 minutes per container

(3) Adjusted Daily Production

218 cpd

b. <u>Move Container to Storage From Marshaling Area</u>

(1) <u>Cycle Times (minutes)</u>

Attach and detach	1.6
Travel	5.0
Maneuver	1.0
	7.6

(2) <u>Adjusted Cycle Time</u>

11.5 minutes per container

(3) <u>Adjusted Daily Production</u>

103 cpd

c. <u>Retrieve Container From Storage to Unstuffing Area</u>

(1) <u>Cycle Times (minutes)</u>

Attach and detach	1.6
Travel	5.0
Maneuver	2.0
	8.6

(2) <u>Adjusted Cycle Time</u>

13.1 minutes per container

(3) <u>Adjusted Daily Production</u>

91 cpd

d. <u>Move Empty Container From Unstuffing Area to Retrograde Storage Area</u>

(1) <u>Cycle Times (minutes)</u>

Attach and detach	1.6
Travel	5.0
Maneuver	1.0
	7.6

(2) Adjusted Cycle Time

11.5 minutes per container

(3) Adjusted Daily Production

103 cpd

e. Move Empty Container From Retrograde Storage Area to Transporter

(1) Cycle Times (minutes)

Attach and detach	1.6
Travel	1.5
Maneuver	1.5
	4.6

(2) Adjusted Cycle Time

7.0 minutes per container

(3) Adjusted Daily Production

171 cpd

2. 4K RTFL Operations (Based on Reference 27)

FM 9-13 [Ref. 29] indicates that the number of pallets per ammunition container can range from 8 to 48. However, to use the simple arithmetic average of these two extremes to represent lifts would not be realistic, due to the differences in quantity of various categories. (For example, although a container of small arms contains 8 pallets, small arms comprise only about 1.0 percent of the total number of MAF ammunition containers.)

Therefore, determination of the productivity figures expressed in "cpd" assumes an average of 12 lifts, or loads, to be extracted from each ammunition container. The rationale for using the figure of 12 lifts per container is based on an average derived from considering the highest consumption categories, i.e., artillery projectiles and Class V(A) bombs. This average is predicated on: downward adjustment of the number of lifts

required to unstuff a container load of either 8-inch or 155-mm projectiles--for 8-inch projectiles, there would be 32 pallets or 16 lifts per container, and for 155-mm projectiles, there would be 36 pallets or 18 lifts per container; and an upward adjustment of the number of lifts required to unstuff a container load of Class V(A) bombs--an average of 8 to 10 pallets per container.

a. Unstuff Containers

Average of 12 lifts per container; 200 feet round trip, and 1.5 mph average speed.

(1) Cycle Times (minutes)

Pick up loads	18.0
Haul Time	13.6
Release loads	4.0
Total	35.6

(2) Adjusted Cycle Time

54.0 minutes per container

(3) Adjusted Daily Production

23 cpd

b. Load Pallets on Trucks

(1) Cycle Times per Pallet (minutes)

Pick up load	0.5
Travel (round trip)	1.0
Position and release load	1.0
Total	2.5

(2) Adjusted Cycle Time

3.8 minutes per pallet

(3) <u>Adjusted Daily Production</u>

315 pallets per day or 26 cpd (average of 12 pallets per container)

c. <u>Move Pallets to or from Storage</u>

(1) <u>Cycle Times per Pallet (minutes)</u>

Pick up load	0.5
Travel (round trip)	3.0
Position and release load	1.0
Total	4.5

(2) <u>Adjusted Cycle Time</u>

6.8 minutes per pallet

(3) <u>Adjusted Daily Production</u>

176 pallets per day or 15 cpd (average of 12 pallets per container)

C. MK48/MK14 OPERATIONS

On roads, the MK48/MK14 could be used to haul about 20 tons of ammunition in a 2-ton container or about 22 tons of palletized ammunition. Thus, the calculations below credit the MK48/MK14 with a 10% greater capacity for hauling palletized ammunition than for hauling containerized ammunition.

Containerized ammunition can be loaded or offloaded more rapidly than palletized ammunition. The LACH can load/offload a container in about 10 minutes; a RTCH can do it in about 6 minutes. A 4K RTFL can load/offload a CEU of palletized ammunition (an average of 12 pallets) in about 46 minutes or 1.1 CEUs in about 50 minutes. Two 4K RTFLs can load/offload 1.1 CEUs in about 25 minutes.

However, if ammunition is shipped from point A to point B in containers, then empty containers must be returned from point B to point A. The most efficient use of the MK48/MK14 is to return with an empty

container whenever a full container is delivered. Thus, if the travel time between A and B is t minutes and full and empty containers are loaded/offloaded at different places at each location, then a typical full cycle for containerized shipping is:

load full container	6 minutes
travel to B	t minutes
offload full container	6 minutes
travel to empty container loading	2 minutes
load empty container	6 minutes
travel to A	t minutes
offload empty container	6 minutes
travel to full container loading	2 minutes
	2t + 28 minutes

For the same situation, typical cycles for palletized shipping would be:

	Loading with One 4K RTFL	Loading with Two 4K RTFLs
load pallets	50 minutes	25 minutes
travel to B	t minutes	t minutes
offload pallets	50 minutes	25 minutes
travel to A	t minutes	t minutes
	2t + 100 minutes	2t + 50 minutes

Adjusted cycle times per CEU are shown in Table E-1, reflecting 1.1 CEUs per cycle for palletized shipping and 1.0 CEUs per cycle for containerized shipping and the adjustment factor of 1.52 for operational efficiency and work delays. Corresponding unit productivity factors (cpd) are shown in Table E-2.

Table E-1
MK48/MK14 CYCLE TIMES
(minutes)

Adjusted Cycle Times per CEU

One-Way Travel Time	Palletized Container Shipping	Palletized Loading With One 4K RTFL	Loading With Two 4K RTFLs
5	58	152	83
10	73	166	97
15	88	180	111
20	103	193	124
25	119	207	138
30	134	221	152
35	149	235	166
40	164	249	180
45	179	263	193
50	195	276	207
55	210	290	221
60	225	304	235

Table E-2
MK48/MK14 PRODUCTIVITY
(cpd)

One-Way Travel Time (minutes)	Container Shipping	Palletized Loading With One 4K RTFL	Palletized Loading With Two 4K RTFLs
5	20.8	7.9	14.5
10	16.4	7.2	12.4
15	13.6	6.7	10.9
20	11.6	6.2	9.6
25	10.1	5.8	8.7
30	9.0	5.4	7.9
35	8.1	5.1	7.2
40	7.3	4.8	6.7
45	6.7	4.6	6.2
50	6.2	4.3	5.8
55	5.7	4.1	5.4
60	5.3	3.9	5.1

Appendix F

GLOSSARY

AAF	air alert force
AAR	American Association of Railroads
ACE	aviation combat element
ADPE	automatic data processing equipment
AE	assault echelon
AFOE	assault follow-on echelon
AOA	amphibious objective area
ARRADCOM	U.S. Army Armament R&D Command
ASP	ammunition supply point
BSA	beach support area
BSSG	brigade service support group
BTP	beach transfer point
cpd	containers per day
CADS	Containerized Ammunition Distribution System
CEU	container equivalent unit
CMA	container marshaling area
CONUS	continental United States
CSS	combat service support
CSSA	combat service support area
CSSE	combat service support element
DACS	Defense Ammunition Center and School
DODIC	Department of Defense Identification Code
DOS	days of supply
DROPS	demountable rack offloading and pickup system
EAF	expeditionary airfield
ECM	electronic countermeasure
ELCAS	elevated causeway
EW	electronic warfare
FAAD	forward air air defense
FIE	fly-in echelon
FLS	Field Logistics System
FMF	Fleet Marine Force
FMFLANT	Fleet Marine Force Atlantic
FPU	front power unit
FSSG	force service support group

GCE	ground combat element
GD	General Dynamic
GFE	government furnished equipment
GS	general support
H&S	headquarters and service
HALFCON	half container
HHMTT	heavy high-mobility tactical truck
HMMWV	high-mobility multipurpose wheeled vehicle
HTLD	High Technology Light Division
IOC	initial operational capability
ISO	International Organization for Standardization
JLOTS	Joint Logistics Over the Shore
LAAM	light anti-aircraft missile
LACH	lightweight amphibious container handler
LAV	light-armored vehicle
LFORM	landing force operational reserve materiel
LFSP	landing force support party
LOGMARS	Logistics Application and Leading Symbology
LOTS	logistics over the shore
LSB	landing support battalion
LVS	logistics vehicle system
MAB	Marine amphibious brigade
MACG	Marine air control group
MACTDS	Marine Automated Cargo Throughput Documentation System
MAF	Marine amphibious force
MAG	Marine aircraft group
MAGTF	Marine air-ground task force
MARCORS	Marine Corps Scenario
MAU	Marine amphibious unit
MAW	Marine aircraft wing
MCR	mobile construction regiment
MGB	medium girder bridge
MHE	materials handling equipment
MILSTAMP	Military Standard Transportation and Movement Procedure
MLRP	Marine Corps Long Range Plan
MMCS	U.S. Army Missile and Munitions Center and School
MMROP	Marine Corps Mid-Range Objectives Plan
MOE	measure of effectiveness
MOTSU	Military Ocean Terminal, Sunny Point, N.C.
MPS	maritime pre-positioning ships
MWSG	Marine wing support group
NALC	Naval Air Logistics Code
NBC	nuclear, biological, and chemical
NCEL	Naval Civil Engineering Laboratory
NSN	National Stock Number
NTPF	near-term pre-positioning force

OCONUS	outside continental United States
PACAF	Pacific Air Forces
PALCON	pallet container
PLS	palletized load system
PWRMS	pre-positioned war reserve materiel stocks
QUADCON	quadruple container
RBU	rear body unit
RLT	regimental landing team
ROC	required operational capability
ROWPU	reverse osmosis water purification unit
RTC	rough-terrain crane
RTCH	rough-terrain container handler
RTFL	rough-terrain forklift
SAC	Study Advisory Committee
SELF	Strategic Expeditionary Landing Field
SIXCON	one-sixth container
SPC	System Planning Corporation
ST	short ton
TCATA	TRADOC Combined Arm Test Activity
TCN	transportation control number
TE	table of equipment
ULC	unit load container
USCG	U.S. Coast Guard

Appendix G

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Appendix I

STUDY TEAM CONTACTS
(CLASS V(A)/NAVY COORDINATION)

9 Sep 83

Hukkala and Carnevale met with LTCol Jewett re Class V(A) policies and supply system. Info from Jewett:

- "Navy (NAVSEA) does not recognize containerization"
- Ammo containerization for MC would be done at Sunny Point, NC.
- Containerized ammo for Marine ground and air forces ashore will come from MPS ships

Jewett provided no Navy POCs by name and requested that we work through him.

21 Sep 83

Phonecon w/Mr. Cliff Stevens, NAVFAC re Program Management Plan for Container Offloading and Transfer System (COTS). No info avail re Navy plans for containerizing ammo.

27 Sep 83

Met Cdr Thomas G. Troy, OPNAV (OP-405), who was attending USAF Easy ISO/Commando Rack Briefing. Briefly discussed Navy planning for ammo containerization. He stated that the Naval ammo depot at Earle, NJ, had done some work in this area, but that he was unaware of any formal program.

6 Oct 83

Phonecon with Mr. Jack Jester, OPNAV (OP-411), who indicated that he had no knowledge of any containerization requirements for Class V(A) and that if MC wanted it, they should formally request it.

17 Oct 83	Visit to 2d MAW, Cherry Point, NC, with LTCol Yeoman. Met with Maj Dave Rowe, Ordnance Officer. He described current Class V(A) packaging and resupply system, and indicated no requirement for containerization.
20 Oct 83	Visit to 2d FSSG, Camp Lyeune, NC, with LTCol Yeoman. Consensus view was that the Marines would prefer to stuff their ammo containers (all types) at the port of debarkation (Sunnypoint).
25 Nov 83	Phonecon with Cdr Troy, OPNAV (OP-405). Knows of no plans for ammo containerization for strategies sealift in support of MC. From what he has heard, he feels that USAF Easy ISO/Commando Rack is a good idea.
6 Nov 83	Visit with Maj Weeks, Aircraft Ordnance Officer, FMFLANT (with LTCol Yeoman). Satisfied with current system whereby the Navy configures "bombs" for Marine air units.
16 Dec 83	Phonecon with Mr. Cliff Skaalen, NCEL, Re NCEL study on Container Marshalling within a Combat Service Support Area.
10 Feb 84	Phonecon w/Cliff Skaalen, NCEL, re container handling equipment.
29 Mar 84	Phonecon w/LTCol Yeoman. He advised that Navy POCs were Harold Decot, NAVSEA (re containers), and referred to Mark C. Bob Schaumburg, NAVMAT (re ammo).
5 May 84	Phonecon with Gordon Mustin NAVSEA Containers re: Plans for containerizating ammo; no money available for upgrading pier facilities in CONUS; Navy has not complied with Army MOA to upgrade Earle NJ.

15 May 84

Phonecon with Bob Schaumburg NAVMAT ammo - Navy has no policy or plans regarding Class V(A) containerization.

END
DTIC
5-86